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The Research Quarterly

of the American Association for Health, Physical Education, and Recreation

Elmer D. Mitchell, Ph.D., Editor

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A Study of the Post-Exercise Heart Rate

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THE wide use of the response of the heart to exercise as a measure of various physical phenomena has led to many and varied procedures. The chief differences in the procedures lie in the variety and strenuousness of the exercise employed, and the phases of recovery used as indices.

Since the most common procedure is to utilize some part of the post-exercise rate, attention is given to this phase in this investigation. The problem is approached by studying the post-exercise response of the heart to bouts of work which have been standardized and measured.

The investigation reported in this study aims to contribute to the understanding of the nature of the response of the normal and the abnormal heart to different intensities of various types of exercise. The response of the heart to various exercises is studied with respect to the following phases: (1) the post-exercise pulse rate, (2) the pulse-ratio, and (3) the recovery time.

Procedure.—For the purpose of counting the heart rate in the investigations herein reported, an automatic counter was devised and has been described.[1] The cardiotachometer is accurate, stable, and simple to operate. It is capable of counting accurately while a simple exercise is performed. The pulse rate is read directly from the counter, thereby eliminating the objection of counting and recording.

The heart rate was recorded in surroundings as free from distractions as possible. The procedure for recording the pulse was as follows: the subject was admitted to the room and directed to strip to the waist. If his chest was extremely hairy he was asked to remove the hair from about a 6-inch square just below the left nipple, with an electric razor. His name, age, and any other historical information desired was recorded and his weight and height were ascertained. The subject reclined on a bed. He was told to lie quietly and to refrain from talking. The cardiotachometer electrodes were attached to the chest and a series of pulse rate recordings were made in the reclining position. The resting rate was recorded in the reclining position, because observations of a continuous record of reclining,

[1] L. E. Morehouse and W. W. Tuttle, "An Electric Pulse Counter," *Jour. Lab. and Clin. Med.*, 24 (August 1930) 1213.

sitting, and standing pulses reveal that the reclining pulse is the least variable. When the rate attained a steady level it was recorded as the resting rate. The exercise instructions were given and demonstrated by the operator. The subject then assumed the starting position and, when he was ready, the exercise was performed.

The cardiotachometer was started at the end of the last movement of the exercise and the subject was directed to lie on the bed and remain quiet. A continuous recording of the reclining pulse was made until the rate returned and remained at the resting level.

Stool-stepping and weight-lifting were the exercises employed. The stool-stepping was performed as described by Tuttle.[2]

A 25-lb. bar-bell was employed in the weight-lifting exercise. The technique was to have the subject stand erect with the weight supported by both hands, at arm's length. At the proper signal, the subject lifted the weight over his head, arms fully extended, lowering it then to the original position of support. The designated number of trials was performed rhythmically with the beat of a metronome.

THE POST-EXERCISE PULSE

The Effect of the Strenuousness of an Exercise on the Reliability of the Post-Exercise Pulse Rate.—In order to study the relationship of the strenuousness of an exercise to the reliability of the post-exercise pulse, two separate post-exercise pulse readings following four intensities of stool-stepping exercises were made, and coefficients of correlation were computed. Twenty men acted as subjects. Each subject came to the laboratory and reclined until his pulse rate reached a steady level. He then performed twenty steps on a stool after which his post-exercise reclining pulse was recorded. After his pulse returned to the resting level, it was again recorded after thirty, and similarly after forty and fifty stool steps per minute. Only eleven of the twenty subjects tested could perform fifty steps per minute. Subsequent tests, one to five days later, were made on all subjects.

The reliabilities at the various intensities are as follows:

Steps	*Reliability*
20	.070
30	.205
40	.720
50	.781

The correlation of two observations of pulse rates following forty and fifty stool steps per minute is high enough to be significant at the 1 per cent level; that is, a coefficient as high as that obtained would occur by chance less than once in a hundred times for samples from an uncorrelated population. The more intense exercises are

2 W. W. Tuttle, "The Use of the Pulse-Ratio Test for Rating Physical Efficiency," *Res. Quart.* 2:2 (May 1931) 5.

strenuous enough to command near-maximum amounts of pulse acceleration which tend to overshadow disturbing factors in the environment. During the light exercises the mildly accelerated pulse is easily further accelerated by extraneous stimuli which make post-exercise pulse readings at these intensities unreliable.

The Pulse Frequency for Thirty Seconds Following Stool-Stepping Exercises of Graded Intensity.—Following observations of the pulse frequency for thirty seconds after stool-stepping exercises, the relationship between the immediate post-exercise pulse and the resting pulse rate was established. Eleven normal male adults were observed in this experiment. The data collected on these subjects is summarized as follows:

Steps per Minute	Mean Pulse per ½ Min. after Exercise	S.D.	Correlation with Resting Rate
10	41.36	5.65	.534
20	46.45	5.83	.513
30	53.73	4.89	.746
40	62.18	7.14	.603

The correlation of the pulse immediately after thirty and forty steps with the resting rate is significant at the 1 per cent level of confidence. Correlations of resting rate with milder exercises although statistically insignificant are also consistently high. An examination of the mean pulse rates for one-half minute following ten, twenty, thirty, and forty stool steps per minute reveals that a direct relationship exists between the post-exercise pulse and the intensity of the exercise.

The Increase in Pulse Frequency Over the Resting Rate Following Stool-Stepping Exercises of Graded Intensity.—What effect does subtracting the resting rate from the rate immediately after exercise have upon the relationship between the post-exercise rate and the resting rate? Using the data collected from the above subjects, the resting pulse frequency for thirty seconds was subtracted from the pulse frequency for the first thirty seconds immediately after four stool-stepping exercises. Correlations of these products with the resting rates were made and are summarized in the following table:

Steps per Minute	*Correlation with Resting Rate*
10	—.644
20	—.401
30	—.402
40	—.020

Although the correlations are too low to be highly significant, at every intensity of the exercise, a negative correlation is found to exist between the resting pulse and the increase in the post-exercise

pulse above the resting rate. Individuals with a low resting pulse tend to show a greater increase in pulse rate due to mild exercise and those with the higher resting rates are least affected.

Subtracting the resting rate from the post-exercise rate does, to some extent, counter-balance the effect of the resting pulse rate upon the post-exercise pulse rate following strenuous exercise. This counterbalancing effect does not operate at the milder intensities of exercise.

A comparison of the mean exercise rates with the resting rates shows that a mild exercise (10 steps) increases the pulse only approximately 30 per cent over the resting level. An intermediate exercise (20 or 30 steps) produces only about a 40 per cent increase, while a more strenuous exercise (40 steps) results in more than a 90 per cent elevation in rate.

The Rate of Pulse Deceleration Following Graded Intensities of Exercise.—The pulse deceleration after exercise may be measured by comparing the rate during the first thirty seconds after an exercise with the rate during the second thirty seconds after the same exercise. Observations of the post-exercise pulse deceleration of eleven normal male adults are summarized below:

Steps per Minute	Mean Deceleration	S.D.	Correlation with Resting Pulse
10	5.19	3.03	—.640
20	10.91	5.91	—.228
30	14.45	3.60	—.064
40	15.64	12.76	.135

The post-exercise pulse deceleration rate is inversely related to the resting rate at the mildest intensity of exercise. The greater increase in beats due to the mild exercise in individuals with low resting pulse rates is accompanied by a much faster fall in rate after the exercise. At the strenuous exercise level this relationship does not exist.

By comparing the mean deceleration rates, it is noticed that the deceleration rate increases as the exercise rate is increased.

The Occurrence of a Secondary Rise in Pulse Rate after Exercise in Individuals with Normal and in Cases of Abnormal Hearts.—Following the first fall in pulse rate after exercise there is observed occasionally a secondary rise in pulse rate. This secondary rise usually occurs at about one and one-half minutes after the exercise and is observed to increase as much as ten beats per one-half minute. This rise occurs most frequently after the more strenuous exercises and lasts for about one-half to three minutes.

In order to study the frequency of the occurrence of a secondary rise in heart rate following exercise in individuals with normal hearts

and others with abnormal hearts, the post-exercise pulse of eleven normal and eight abnormal cases is recorded.

The chi-square test is applied to the data to test the hypothesis that there is no relationship between normality and abnormality of the heart and the factor of secondary rise of pulse rate. Chi-square was found to be .12. Since this value would be found by chance approximately 70 per cent of time, it is impossible to reject the hypothesis that there is no relationship.

THE PULSE-RATIO

The Effect of the Resting Pulse Rate on the Pulse-Ratio.—In order to observe the effect of the resting pulse rate on the pulse-ratio, the significance of a difference in means of 29 subjects with resting rates of 58 or less beats per minute and 34 subjects with resting rates of 86 or more beats per minute is estimated by means of the *t*-test.

The mean pulse-ratio of the low resting pulse rate sample is 2.909, and of the high is 2.757. The value of t is 2.204. In a large number of samples like this, the value of t as large as 2.204 would be found only between 5 per cent and 2 per cent of the time.

With such a high value of t, the hypothesis that the samples were drawn at random from the same population may be rejected and it may be said with a high degree of confidence that the means do differ. Low resting rates are associated with high pulse-ratios and high resting rates with low pulse-ratios.

The Relationship of the Rate of Stool-Stepping Exercise to the Pulse-Ratio.—The linear proportionality between the pulse-ratio and the rate of the exercise reported by Tuttle and others[4,5] does not extend to light exercise. In fact, a stool-stepping exercise of ten steps per minute may produce a higher pulse-ratio than a similar exercise of twenty steps. An observation of the pulse-ratios of five normal subjects tabulated below bears out this relationship.

Subject Number	Pulse-Ratio at 10 Steps	Pulse-Ratio at 20 Steps	Pulse-Ratio at 30 Steps	Pulse-Ratio at 40 Steps
115	2.19	2.13	2.52	3.29
116	2.10	2.09	2.51	3.16
117	2.01	1.97	2.44	3.09
118	2.01	1.97	2.31	2.65
119	2.01	1.99	2.19	2.52

THE RECOVERY TIME

The Relationship of the Intensity of Weight-Lifting Exercises to the Recovery Time.—The average recovery times of ten normal male

[4] W. W. Tuttle, "Response of the Heart to Exercise of Graded Intensity," *Proc. Soc. Exper. Biol. and Med.*, 29 (March 1931) 598.

[5] W. W. Tuttle and G. Wells, "The Response of the Normal Heart to Exercises of Graded Intensity," *Arbeitsphysiol.*, 4 (Feb. 1931) 519.

adults after lifting a 25-pound weight 5, 10, 15, 20, and 25 times per minute are tabulated below:

Lifts per Minute	*Recovery Time in Minutes*
5	2.7
10	2.8
15	3.3
20	10.9
25	14.0

An examination of this table reveals that the recovery time is prolonged as the intensity of the exercise is increased. In the majority of subjects, the heart rate returns to the resting level within 3 minutes after 5 to 15 lifts. After 20 and 25 lifts, however, most subjects require 9 or more minutes to recover.

The greatest variation in recovery time between subjects is found when the more intense exercises are used. Everyone responds nearly alike to the mild exercises, 5 to 15 lifts, but after 20 to 25 lifts, a wide variation is noted.

The Effect of the Resting Pulse on the Recovery Time.—Correlations between the resting rate and the recovery time following the five intensities of weight-lifting exercises performed by the above subjects are shown below:

Lifts per Minute	Mean Recovery Time	S.D.	Correlation with Resting Pulse
5	2.70	2.02	—.200
10	2.80	1.13	—.034
15	3.30	1.60	.078
20	10.90	7.00	—.093
25	14.00	6.20	—.266

By referring to this summary it may be seen that there is no significant relationship existing between the resting pulse and recovery time at any intensity of the exercise.

SUMMARY AND CONCLUSIONS

The development of an electric cardiotachometer makes possible a more accurate study of certain phases of the response of the heart to various types of exercise, namely; (*a*) the nature of the recovery of the pulse rate following exercise, and (*b*) the factors which affect the response of the heart to exercise.

Data on the post-exercise pulse rate support the following conclusions:

1. The reliability of the pulse rate for two minutes after exercise is directly related to the strenuousness of the exercise. Thus, if the response of the heart to exercise is to be measured, the exercise must be strenuous enough (40 to 50 stool steps per minute) to overshadow environmental stimuli which affect the pulse rate

after light exercises (20 to 30 stool steps per minute) to such an extent that successive readings are unreliable.

2. The rate of the first few heart beats immediately following exercise is directly related to the intensity of the exercise and the resting rate.

3. The post-exercise increase in pulse rate above the resting level is directly related to the intensity of the exercise, and at mild intensities of exercise is inversely related to the resting pulse rate.

4. The rate of pulse deceleration following exercise is directly related to the intensity of exercise and the elevation of the pulse rate immediately after exercise. After a very light exercise, it is inversely related to the resting pulse rate.

5. A secondary rise in pulse rate after exercise is a normal, but variable phenomenon.

6. The pulse-ratio of individuals with high resting rates is lower than the pulse-ratio of those with low resting rates. The pulse-ratios are directly proportional to the rate of the exercise except at extremely slow rates, which may produce pulse-ratios higher than the pulse-ratios of faster rates of exercise.

7. The recovery time is prolonged in relation to the intensity of the exercise and is not related to the resting pulse rate.

8. In general, where exercises are used to differentiate individuals on the basis of the post-exercise pulse rate, the pulse-ratio, and the recovery time, they must be strenuous in order to give reliable results.

Motor Educability Tests for Women College Students

By S. Lucille Hatlestad, Ph.D.
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Kansas State Teachers College, Pittsburg

SEVERAL tests, purporting to give some information about an individual's ability to perform motor skills, have come to our attention since 1927.[1]* Among them are those which have been termed stunt-type tests. Notably few of the proposed tests in our field have had universal application so we have been at a loss in making interpretations from situation to situation. In the hope of arousing interest in overcoming this handicap, the problem was begun by administering, to a group of women college students, both Brace's Motor Ability Test[2] and the Iowa Revision of the Brace Motor Ability Test,[3] as well as the Johnson Physical Skill Tests.[4] In addition to these, a fourth test, also of the stunt type, devised by Kenneth Hill,[5] was used. Each of the four tests was then T-scored.

THE PURPOSE

At the time the project was begun the sole purpose was to provide a comparative scheme for those interested in using one or another of the tests. Since then, however, two practical applications in the field of research and one in the field of testing have come to the writer's attention. These are related in the discussion.

PROCEDURE

One hundred thirty women in physical education classes, at the Kansas State Teachers College of Pittsburg, were each given the four named tests. Their average age was twenty-two years; and the age range, seventeen to twenty-nine years. The subjects were approximately evenly divided among six classes, namely: tap, beginning folk and modern dancing, gymnastics, and two sections of "required physical education."

The tests were given and scored according to the instructions of the test authors excepting that the Brace Motor Ability test was scored in two ways: the first, as the author instructed, i.e., "pass or fail on the first trial" with one point being the score for "pass" and zero for "fail." In the remainder of this paper this scoring scheme is referred to as Brace$_1$.

The second method, the results of which are hereafter referred to

* Numbers refer to the Bibliography at the end of this article.

as Brace$_2$, consisted of scoring a success in each stunt on the first trial with two points; but if there was a failure on the first trial, with success on the second trial, the stunt was scored with one point. If neither trial was successful, the stunt was scored zero. This is identical with the scoring scheme for the Iowa Revision of the Brace Motor Ability Test.[1]

ANALYSIS

Intercorrelations of the raw scores made on these four tests are shown in the following table.

TABLE I

COEFFICIENTS OF INTER-CORRELATION OF TESTS

	Brace$_2$	Iowa Rev. Brace	Hill	Johnson
Brace$_1$	.98	.81	.64	.46
Brace$_2$		.82	.67	.50
Iowa Rev. Brace			.75	.42
Hill				.49

The raw scores on the four tests were converted into T-scores by using McCall's method[6] of percentile ranking each score division unit and selecting the corresponding T-score for the percentile rank of the score directly from the prepared table. The T-scores thus selected are given in Table II.

DISCUSSION

Examples of applications of this type of material may be found in Dr. Gladys Scott's recently published article[7]; and in Miss Evelyn May Triplett's thesis[8].

Dr. Scott stated to the writer, in November, 1939, that she now had data on over 1,000 subjects, and believed her scores were fairly stable. It was understood that the stabilized scores agree with those in Table II, listed as Scott's Iowa Revision of Brace raw scores, reproduced from Dr. Scott's publication[7].

Miss Evelyn May Triplett[8] attempted to find, in a study of college women enrolled in beginning tap dance classes, what tests might possibly be useful in selecting such talent. With particular reference to the Johnson Physical Skill Tests[4], Miss Triplett's T-scores do not agree with those of the writer. An examination of the two sets of data revealed that the central tendencies compared as follows:

Johnson Test	*Number of Subjects*	*Mean Scores*	*Standard Deviations*
Triplett's data	150	51.6	13.9
Writer's data	130	66.4	11.9

The critical ratio, computed for the above data, was found to be 9.6, indicating that there was a significant difference in the mean performance of the two groups of students. This might have been

TABLE II

T-SCORES OF THE TESTS

T-Scores	Brace$_1$ Raw Scores	Scott's* Iowa Rev. Brace Raw Scores	Brace$_2$ Raw Scores	Iowa Rev. Brace Raw Scores	Hill Raw Scores	Johnson Raw Scores
79	20		40			100
78						99
77			39			98
76	19	20			24	97
75			38			96
74						95
73	18		37		23	94
72		19				92
71			36			91
70		18		20	22	90
69	17		35			89
68		17				88
67			34	19	21	86
66	16	16	33			85
65			32	18	20	84
64		15				83
63	15		31			82
62				17	19	80
61			30			79
60	14	14		16		78
59			29		18	77
58						76
57	13	13	28	15		75
56			27		17	74
55		12	26	14		72
54	12					71
53		11	25		16	70
52				13		69
51	11		24		15	67
50		10	23	12		66
49			22			65
48	10	9			14	64
47			21	11		63
46						61
45	9	8	20	10	13	60
44			19			59
43		7				58
42	8		18	9	12	56
41		6	17			55
40				8	11	54
39	7		16			53
38		5				52
37			15	7	10	51
36	6		14			50
35		4				48
34			13	6	9	47
33	5		12			46
32				5		44
31		3	11		8	43
30	4					41
29			10	4		40
28		2	9		7	39
27	3			3		38

* These scores are referred to in the discussion following this table.

TABLE II (Cont'd)

T-Scores	Brace$_1$ Raw Scores	Scott's* Iowa Rev. Brace Raw Scores	Brace$_2$ Raw Scores	Iowa Rev. Brace Raw Scores	Hill Raw Scores	Johnson Raw Scores
26			8			36
25					6	35
24	2		7	2		34
23			6		5	33
22				1		31
21	1	1	5			30
20			4		4	29
19						28
18			3			26
17			2		3	25
16						24
15			1		2	23
14						21
13					1	20

due to a difference in the standards of scoring used by the two investigators; or it might have been due to a real difference in the performance of the two groups. The former seems more plausible, and points to the necessity for more objectivity in scoring the Johnson test. It is recommended also because a like discrepancy is not found between Scott's Iowa Rev. Brace raw scores and the writer's data, shown in Table II.

It is suggested then that if any investigator had at his disposal T-score tables of accepted tests in our fields he would have not only a means of selecting or describing and equating groups, but also he would have a means of interpreting the results of his analyses more meaningfully.

Suggesting an application of the use of such T-score tables in the field of testing, the Johnson, Hill, or Brace Tests (the latter scored on either the first trial alone; or on both the first and second trials) could be substituted for the Iowa Revision of the Brace Test in giving and scoring McCloy's General Motor Capacity Test[9]. For example, in Table II, a T-score of 60 represents a Brace$_1$ score of 14, Scott's Iowa Rev. Brace score of 14, the writer's Iowa Rev. Brace$_1$ score of 16, and a Johnson score of 78.

If one wished to use the data in Table II, in computing General Motor Capacity Scores for college women, he should multiply the T-score value of any one of the six tests included in these data, by the constant value of 2.20 before adding the score, in points, to the point values of the Sargent Jump and Burpee Test[10]. For example, if a college woman student scored 75 on the Johnson Test, the corresponding T-score value of 57 is multiplied by 2.20, equalling 125.4 points, which is then added to the point values of the Sargent Jump and the Burpee test, to give the General Motor Capacity Score for

this particular woman student. Reading across Table II, from right to left, this same college woman, had she been given the following tests, would have been scored 125.4 points for 15 on the writer's scale of the Iowa Revision Brace$_1$ raw scores, 28 on the Brace$_2$ raw scores, or 13 on either Scott's Iowa Revision Brace raw scores or the Brace$_1$ raw scores. In like manner, the student should be given 123.2 points for scoring a 17 on Hill's test, this being the product of 2.20 and the T-score of 56, which corresponds to the above raw score of 17.

Providing there are those who might be interested in adding to and revising this material, the central tendency data are herewith presented:

TABLE III

CENTRAL TENDENCY DATA

Tests	Means	Standard Deviations
Brace$_1$	10.7	3.1
Brace$_2$	23.2	6.2
Iowa Rev. of Brace$_1$	12.1	3.8
Hill	14.8	3.5
Johnson	66.4	11.9

SUMMARY

1. The Brace Motor Ability Test, scored in two ways, Iowa Revision of the Brace Test, Hill Stunt Type Test, and Johnson Physical Skill Test have been T-scored for college women students, whose average age was twenty-two years.

2. T-scored Brace$_1$ raw scores, Scott's Iowa Revision Brace scores and the writer's Iowa Revision Brace$_1$ scores, given in Table II, show fairly close agreement.

3. Comparison of the performance of two groups of college women students on the Johnson Physical Skill Test shows that there might be a need for greater objectivity in the scoring of this test; and that reliable and available T-scores on accepted tests in the field of physical education might prove more useful in doing and interpreting the results of research.

4. Substitution of the T-scores for either the Brace, Hill, or Johnson Tests may be made for the Iowa Revision of the Brace Test scores, in computing the General Motor Capacity Test scores.

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The Practice and Fatigue Effects in the Sargent Test

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THE Sargent jump test, originated by D. A. Sargent [11*] in 1921, was first validated by L. W. Sargent,[12] who called it a test of "neuromuscular efficiency involving strength, speed, coordination, and driving power." Collins and Howe [3] also contributed to its validation, as did Bovard and Cozens.[1] McCloy,[9] in 1932, found experimental evidence for the validity of the test, and stated that it was the best single test available for predicting "power." Coleman,[4] in a factor analysis study, found that the test was loaded .29 with "force" and .58 with "speed." Harris [8] found similar but higher loadings (.33 and .73). Other factor analysis findings are similar.

Van Dalen,[13] summarizing the literature in 1940, was "impressed with . . . certain vital omissions. In only one case was adequate practice given. . . . " It was concluded that " . . . The Sargent Jump when standardized, practised, and correctly administered is undoubtedly a valuable test. . . ." These statements were also made by McCloy.[9] Van Dalen's experiment was primarily concerned with the relative validity of certain variant forms of the Sargent test, and the McCloy report dealt chiefly with the development of multiple regression equations for predictive purposes. Apparently neither of these investigators attempted to standardize objectively the amount of practice that was given, since both stated ". . . The Sargent jump was taught to the group until the form was learned and the performance of the jump was mechanically satisfactory." No criteria of learning or of satisfactory performance were mentioned, and it is quite possible that the quantitative disagreement in the two studies was due to lack of standardization. The two experiments appear to have been comparable in other respects, since, as subjects, both used senior high school boys who had considerable practice and training in both track and field events and the Sargent test itself. The Sargent test techniques appear to have been identical, and the track and field events differed only in the substitution of a 6-second run for the 100-yard dash (which should have had little or no effect

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*** Superior figures refer to numbered Bibliography at end of article.**

on the correlation). The correlation coefficient was .810 in Van Dalen's experiment and .651 in McCloy's. The difference is statistically reliable; if not due to the reason suggested above it could be the result of a superficial factor of untested validity arising from Van Dalen's use of "best" scores in the track and field test as well as in the Sargent test.

Bovard and Cozens,[1] in an earlier experiment, had standardized the practice period at three jumps in one phase of their study, but mentioned no quantitative study of the practice effect.

It seems clear that investigators of the Sargent test are of the opinion that practice has an important influence on its validity. If practice is important, it follows directly that an individual's test score will have to be interpreted as a function of the amount of practice allowed and the degree to which he can profit by practice, as well as his ability in the test itself.

In general, three methods for standardizing practice are available. The first (which was used by Bovard and Cozens) gives all subjects a uniform amount of experience with their problem. This method is open to certain theoretical objections, since, if subjects vary in the rapidity with which they perfect their performance, their test scores will be a function of both speed of learning and final performance level. Logically, this objection tends to vanish if individual differences in amount of learning can be shown to be small as compared with individual differences in final performance. It seems important, also, to determine the optimum number of practice trials.

The second method involves giving practice until some standard amount of improvement has been attained. The objections here are similar but stronger, and in addition, there is the practical difficulty of obtaining and calculating the required data.

The third method requires the continuous observation of the individual learning curves and the discontinuation of practice just as learning is completed, or, optionally, after a standardized amount of overlearning. This method, while theoretically attractive, seems impractical because of the time and labor required. McCloy and Van Dalen used a modification of this method, teaching the technique to the "group" and apparently making a subjective estimate as to when "form" had been learned. Van Dalen's results seem to indicate that "form" is closely related to test performance. Quantitatively, the justification for the use of this method seems to rest on McCloy's[9] report that his Chinese physical education majors, who were well trained in the technique of the test, yielded a higher validity coefficient than the "final" group who had only 10 minutes of instruction, and perhaps a similar comparison between two groups of high school boys. In the first of these comparisons, the gain in validity is definitely not significant statistically. In the second, the difference is prob-

ably not significant either, but since the difference in practice was in the criterion rather than the test, the results do not bear on the present problem. The relative merits of these methods of dealing with the practice effect cannot be decided on the basis of the literature.

Another interesting question has to do with the way the test is scored. Should the "best" jump be used, or should an average of several be used? Bovard and Cozens [1] raised this question, but did not answer it. In their experiment, the "best" jump was used, regardless of where it came in the series. Apparently both McCloy and Van Dalen used the "best" jump of several, but neither has explained this part of his procedure. In his reliability study, McCloy [9] used the "best" jump of a series of three.

APPARATUS AND METHODS

The Sargent test performance was measured with a simplified and improved form of Bovard and Cozens leap-meter (See Fig. I). The head-piece was constructed of woven fabric straps, with buckles placed to permit adjustment of both vertical and horizontal circumferences. A light-weight non-stretching braided cord was attached to the head-piece and passed over a light-weight 1.5 inch cone-bearing laboratory pulley rigidly suspended 15 feet above the subject.

From the upper pulley, the cord passed through a second mounted on the wall in the vertical plane, and a third that turned it horizontally along the wall. Attached to the horizontal end of the cord was a 9.5 ft. spring that was stretched to 14 feet when the subject was attached, exerting a force of 0.28 pounds on the subject. On the wall behind the horizontal part of the cord was placed a 6 ft. by 5/16 in. metal rod carrying two light-weight sliders. One of these was attached to the cord, and moved back and forth with the subject's jump. The other slider had a friction device, and was arranged so that it was pushed laterally by the first as the subject jumped up, but stayed in place at this maximal position as the subject returned to the floor. A measuring stick was placed behind the horizontal rod, and arranged to slide back and forth so that its end could be adjusted to coincide with the position of the slider when the subject was standing erect. After a jump was made, its amount could be read directly by noting the amount that the friction slider had moved along the measuring stick. After reading, the friction slider was returned to zero before the next jump. It should be noted that all moving masses were kept small in order to avoid lag and over-shooting of the indicator, and that the spring * exerted minimal force on the subject.

*** An automatic fly-casting reel of the type used by trout fishermen has been found satisfactory as a means of producing suitable tension on the cord.**

The subjects were brought into the experimental room individually, and, after the head-piece was adjusted, were shown the picture of the subject in jumping position in Bovard and Cozens' monograph. Then a verbal explanation of the technique was given, followed by a single demonstration made by the experimenter. No preliminary

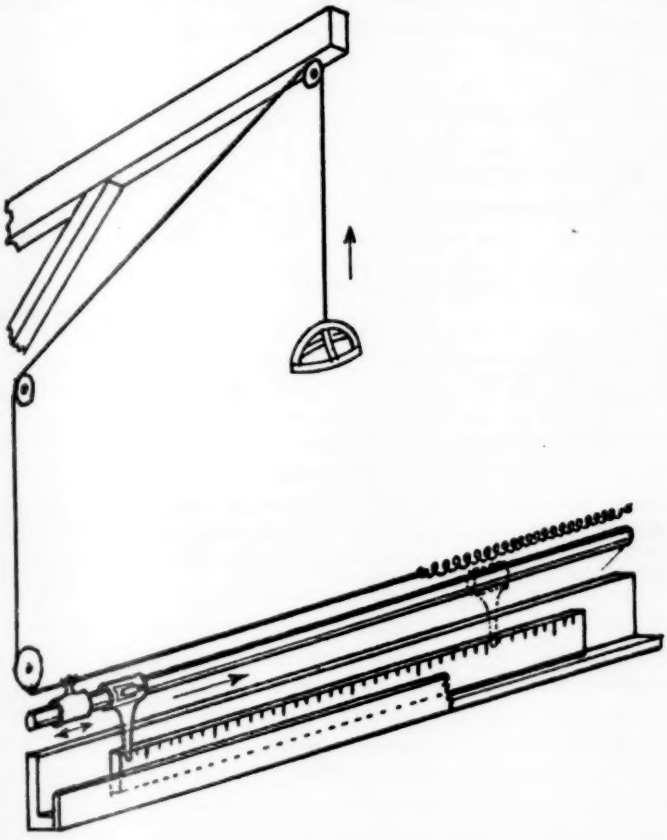

FIGURE I. Diagram of the apparatus. The diagram is semi-schematic. Actually, the sliders are much smaller than they appear here; and the slider rod is mounted so close to the measuring stick that the pointer is not required.

practice was allowed. The technique was that described by McCloy except for the omission of the pause at the bottom of the dip. The subject was asked to keep oriented frontally by reference to a pair of wire sights placed on the wall in front of him, while his lateral orientation was checked by the experimenter. The floor was covered with thin rubber matting to avoid slipping. Ordinary shoes and clothing were worn, with coats or jackets removed. The jumps were made in pairs of two about one-half minute apart, with approxi-

mately three minutes between pairs. Just before the tenth jump, the subject was told that it would be the last, and motivated verbally to a maximal effort.

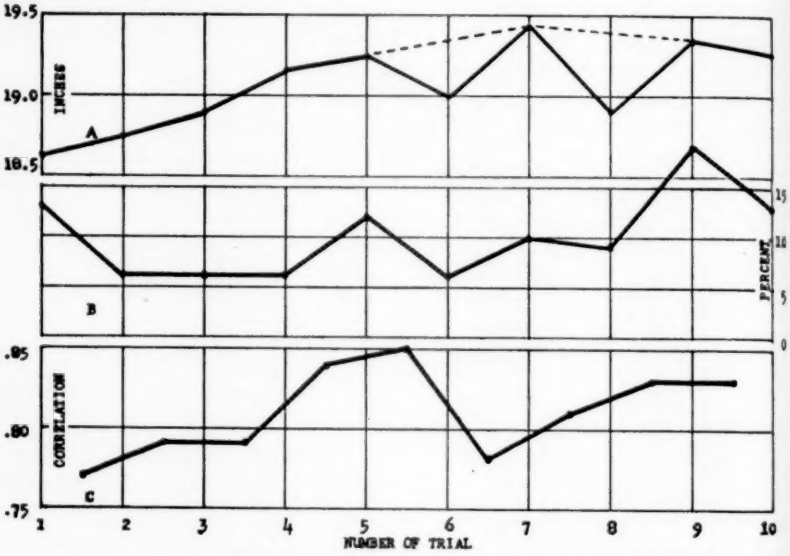

FIGURE II. Curve *A* illustrates the effects of fatigue and practice on mean performance. Curve *B* shows the effects of fatigue and practice on the percentage of "best" jumps that occur in each trial. Curve *C* shows the effect of practice on the inter-trial correlations.

In choosing a criterion for the present study, three arguments seemed obvious. The criterion could be selected (1) to have as many performance elements as possible in common with, or similar to, the Sargent test, (2) to be a general test of athletic ability or athletic performance, (3) to test specific athletic abilities or performances or types of performances that *a priori* would be expected to show a high degree of relationship with the Sargent test. It was recognized that this last argument was intermediate between the first and second, hence the broadest possible generalizations concerning the Sargent test would result if criteria were selected to represent extreme cases under (1) and (2). It was quite apparent that the criterion that would have the maximum number of performance elements in common with the Sargent test (argument 1) would be the test itself, and the validity co-efficients in this case would be the Sargent test reliabilities. For a criterion that would meet the conditions of argument (2), the results presented by Cozens [5] in his monograph led to the choice of his test of "General Athletic Ability."*

* The justification of the term "general" in connection with this test does not necessarily require the assumption that it is loaded with a general factor, since the test items are representative work-samples.

The criterion scores were obtained by testing the subjects on Cozens [6] "General Athletic Ability" battery, Form I. This was altered slightly by substituting a 330-yard run for the quarter-mile event. Norms for the 330 appear in another publication by Cozens.[7] All subjects were given the Athletic Ability test on the same day, but since the Sargent test was given individually, the period between the two tests was variable and in some cases amounted to several weeks.

The subjects, 61 in number, were male university students. All were "physically fit." None was a physical education major. They were heterogeneous with respect to participation in college athletics, and average in athletic ability. Characteristics of the group are given in some detail below,* as generalizations from any experimental study are directly conditioned by an adequate description of the sample.[10]

EFFECTS OF PRACTICE

Table I gives the mean Sargent test scores in inches. The third line of this table gives the critical ratios of the differences between successive trials. Inspection of this table reveals a consistent rise in performance level (i. e., a practice effect) up to the sixth trial. It can also be seen that the means of the odd-numbered trials plot into a regular curve throughout the series (Figure II), and that the sixth, eighth, and tenth trials show a decrement when compared with the trials that immediately preceded them, and a recovery to the trend in the trials following immediately.

It seems very likely that the even-trial decrements are evidence of a fatigue effect, since the trials were made in pairs with a 3-minute rest *between* the pairs and a ½-minute rest *within* each pair. There is a *rise* in performance during the 3-minute rest, and a *drop* in per-

* The subjects ranged in age from 19 to 24 years, with 68.8 per cent in the 20- to 22-year group. About 34 per cent reported that they had played on a college team, and of these less than half had made a letter or numeral. Very few were active in university sports at the time of the test. Twelve per cent had played football, soccer, or baseball (but usually football) on a college team, and an additional 5 per cent included basketball or track as well. Another 7 per cent were track and field participants only, and 5 per cent were basketball players. Thirteen per cent were active in intramural sports. In high school the participation had been two times greater; 43 per cent made letters or numerals and an additional 26 per cent played on a team. Eight per cent had limited their participation to track and field, 5 per cent to basketball, 5 per cent to basketball and track, and 18 per cent to football, soccer, or baseball (usually football). Eight per cent had included basketball with football, and 15 per cent had also included track. Fifty per cent of the total group, therefore, had been on a high school basketball or track and field squad, or both, and most of these had included other sports as well.

In height and weight, 54 per cent were almost evenly divided between Cozens's "tall-medium" and "tall-heavy" classification, 26 per cent were "medium-medium" and 13 per cent were "medium-heavy." In athletic ability as measured by the Cozens test, the mean score was 352 and the standard deviation 71, as compared with a normal mean of 350 and a standard deviation of 81. Two subjects reported having taken the Sargent test previously, but none within the preceding two years. Six subjects were not questioned.

TABLE I

EFFECTS OF PRACTICE ON MEAN PERFORMANCE, ON INTER-TRIAL CORRELATION, AND ON THE PERCENTAGE OF "BEST JUMP IN TEN" THAT OCCURS IN EACH TRIAL

Trial	1	2	3	4	5	6	7	8	9	10
Mean	18.61	18.74	18.89	19.15	19.23	18.98	19.43	18.89	19.33	19.26
C.R.	....	.52	.63	1.20	.39	1.18	2.08	2.23	2.04	.38
r	....	.77	.79	.79	.84	.85	.78	.81	.83	.83
%	13.	6.	6.	6.	12.	6.	10.	9.	19.	13.

formance in the last three of the ½-minute rests. Absence of the decrement in the earlier trials is consistent with a "fatigue" hypothesis, as fatigue would be cumulative over the entire series if recovery were incomplete in the 3-minute rest periods. The decrement for the tenth trial is probably lessened because of an end-spurt resulting from the special motivation that was given. The serial position of the "best" jumps (lower line of Table I) gives supporting evidence as to the presence of both the practice effect and the fatigue effect.

The statistical significance of the gain in average performance level (using the first trial as a reference level) is also found to increase with practice. There are 87 chances in 100 that mean performance is higher in trial three, 98 in 100 that trial five is higher, 99.9 in 100 that trial seven is higher, and 99.5 that trial nine is higher. The even numbered trials were not used in this comparison because of the fatigue effect mentioned above. In both mean performance and significance of increment, there is some evidence of a plateau following trial seven. The data at hand do not indicate whether this plateau results from completion of learning, antagonistic effects of fatigue, or both, but this is largely an academic question since it would be impractical to allow much longer rest periods or many more practice trials in an actual test situation.

The correlations between successive trials are given in the fourth line of Table I. These correlations (which may be interpreted as reliability coefficients) rise fairly regularly with increasing practice up to the sixth trial, and then make a statistically significant drop (99.3 chances in 100) * followed by another rise in the later trials.

It is not unlikely that the antagonistic influences of practice and fatigue have their maximum differential effect on individual subjects near the region of the seventh trial.

INDIVIDUAL DIFFERENCES IN PRACTICE INCREMENT

In the introduction, the hypothesis was advanced that if individual differences in *amount* of learning can be shown to be small as compared with individual differences in final test performance, the use

* The critical ratios between correlation coefficients found in this study, being based on *correlated* data, are calculated from the analogue of the familiar formula for the critical ratio of the difference between correlated averages. The product-moment method is used throughout.

of the method of uniform practice is justified. The conventional test for the presence of individual differences is the determination of their reliability. A reasonable approximation of the reliability of the practice increments can be obtained by correlating the differences between "second trial" and "best" scores with the differences between "first trial" and "next best" scores. This correlation is .42 as compared with a "last trial" reliability of .83. The per cent determinations ($\sqrt{1-r}$) yielded by these coefficients are 24 and 59, respectively.

Another estimate of the reliability of the practice increment can be made by correlating the differences between the first and ninth trial scores with the differences between the second and tenth trial scores. This turns out to be .50, which corresponds to a per cent determination of 29. Here again, individual differences in practice increment appear relatively small. Both practice increment reliabilities are smaller than the tenth trial reliability by an amount that is statistically significant. It seems fairly clear that individual differences in amount of learning are small as compared with individual differences in final performance, or for that matter, performance after any uniform number of practice trials since all the inter-trial correlations are close to .80 (see Table I). Additional evidence in support of the hypothesis will be given further on.

RELIABILITIES OF DIFFERENT METHODS OF SCORING

The estimated reliability for scores obtained by averaging ten trials is .97 (odd-even trials, Spearman-Brown corrected). The reliability for the average of five trials is .92. Between the average scores of the first three trials and the second three the correlation is .78, and between the second three and the last three, .88. To determine if this statistically significant increase in reliability of the middle and last third of the three-trial averages is characteristic of the middle or of the last trials, let us refer to the inter-trial coefficients of Table I. The average intercorrelation between trials 4-5 and 5-6 is about .85, and between trials 8-9 and 9-10, .83. The difference is not significant. This finding may also be taken as further evidence of a plateau effect in the last part of the practice series.

From this analysis and a similar analysis of the five-trial reliability, it follows that: (1) the reliability of scores based on the average of three trials is increased if preceded by a three-trial practice period, (2) no further increase of significance occurs with additional practice, and (3) the additional gain in reliability by using a five-trial average preceded by a five-trial practice period is small and of questionable significance. The scores of a single trial preceded by one or two practice trials are definitely less reliable (as might be expected) than are average scores. To secure a reliability

that is higher than that of a single trial, it appears to be necessary to (1) give a practice series of three trials before the test series, or (2) average the scores of five or more trials. The average of ten trials yields scores of greatest reliability. The standard deviations of the scores range from 2.3 inches for "average of 10 trials" to 2.4 to 2.8 inches for single trials.

The Sargent test reliability of .61 obtained from 35 subjects by Bovard and Cozens [1] was based on the "best" scores in a composite series consisting of three unpracticed jumps followed by as many jumps as the subjects could make in 15 seconds. The retest was made within a week. McCloy [9] obtained a reliability of .77 from an unspecified number of subjects when he correlated the "best of three" jumps with a presumably immediate retest. These coefficients are probably not to be taken at their face value, since it can be shown that a spurious correlation may be introduced into *uncorrelated* data by the technique of selecting the "best" of a series of performances.* Nevertheless, it is of interest to see the magnitude of the coefficients obtained by this method when it is applied to the data at hand. Considering all ten jumps, "best" correlates .97 with "next best." "Best of first five" correlates .93 with "best of last five" trials. "Best of second three" correlates .80 with "best of first three" and .88 with "best of last three." Obviously there is no gain in reliability through the use of this scoring method. If a reasonable allowance is made for the "selection" factor, there appears to be a *loss* in reliability.

There is another line of evidence which indicates that "average" scores are more representative of individual differences in test performance than are "best" scores. Consider the average of the first five trials as a measure of performance, i. e., as a criterion. It is not necessary to assume it to be the best possible measure; it is quite sufficient to show that it is a good measure, and the findings as to reliability are ample justification for this assumption. Now, consider the last five trials as a second experimental measure of test performance that can be scored in two ways, namely by the use of "best" scores and "average" scores. "Best" scores are found to correlate .90 with the criterion, whereas "average" scores correlate .93. The use of the *last* five trials as a criterion also gives a higher correlation for "average" scores. It should be noted that "best" scores cannot be used as a criterion in this type of analysis due to

* For example, selecting the 10 cases in the present study who made an average jump of 19 inches, it is found that the "average" scores of the first and last five trials correlate .18, which does not differ much from the theoretically expected zero; the "best" and "next best" scores, however, correlate .33. Selecting the eleven subjects who made an average jump of 18 inches the averages of the first and last five trials correlate —.16 instead of zero, but the "best" and "next best" correlate .85. Similar relationships exist in the sub-series. It follows directly that reliabilities calculated from "best" scores contain a superficial factor. Statisticians are familiar with this type of "selection" factor, which is ordinarily thought to be spurious.

the inclusion of the "selection" component, but there is little reason to suspect that average scores contain such a factor. Any possibility of this can be avoided by taking the scores of some *single* trial as a criterion; in this case, the criterion scores are neither "best" nor "average." The seventh trial appears suitable, since it is in the plateau region, has the highest mean performance of any trial, and has a typical validity with respect to athletic ability. The "best" scores of the preceding six trials correlate .86 with the seventh trial scores; the "average" scores of these six trials correlate .88 with the seventh trial. These differences in favor of the method of "average" scores are not large and probably cannot be accepted as final proof, but they certainly show that there is no real advantage to be gained through the use of the method of "best" scores. It will be shown later that the results of this analysis are in agreement with the findings when an external criterion is used.

The reliability for the first and second groups of three agrees very closely with the coefficients reported by McCloy,[9] and does not differ to a statistically significant degree from Bovard and Cozens'[1] coefficient. The discrepancy is lessened when the attenuating effect of the test-retest interval is taken into account. There is another point, however, concerning which the writer wishes to express disagreement with McCloy, namely, the contention that McCloy[9] has shown a higher correlation when the "best" score from more than one day's trials are used. Apparently the justification for this conclusion is the correlation of .854 between the "best" scores of *six* trials, half made on one day and half on another, and a similar retest series of six. McCloy compares this coefficient with the coefficient of .770 that he found for the "best" score of *three* trials correlated with another three trials made on the same day, and has neglected to correct for the discrepancy in the number of trials allowed. When this correction is made, his evidence indicates that the use of the "best" score from two days trials yields a *lower* reliability, not a higher one.

Coleman[4] has reported a reliability of .958 for a modified Sargent test, using the method of "best" scores. The number of trials was not stated. This coefficient is not inconsistent with the findings of the present study.

VALIDITY OF DIFFERENT METHODS OF SCORING

The correlations between single trials in the Sargent test and total Athletic Ability scores indicate that the trend is in the direction of an increase with practice, but the change is small, and, in the first five trials, irregular. In Table II it is seen that the coefficients rise above their average value in trial 3, and drop below it in trial 5, but neither of these changes is statistically reliable.

TABLE II

VALIDITY OF DIFFERENT METHODS OF SCORING

Trials	1	2	3	4	5	6	7	8	9	10
r	.39	.38	.46	.36	.32	.41	.42	.42	.45	.40
r (av.)			.42			.39	....			.44
r (best)			.45			.34	....			.37

The third line of the table gives validity coefficients for scores based on the average of three trials, and the fourth line, coefficients for the "best" scores in three. None of these coefficients shows significant differences. The validity of the average of the last five trials is .48, which is higher than the coefficient for the first five (.42) is higher than that for any score based on three trials, and significantly higher than either of the corresponding "best of five" coefficients (.37 and .39 respectively). For the average of 10 trials, the validity is only .44, but this is higher than the "best of 10" coefficient, which is .40. Summarizing these data, the validity coefficients for "best" jump are on the average .045 lower than the corresponding coefficients for "average" jump, half of the "best" jump coefficients are lower than any of the average jump coefficients, and the highest of the "best" jump coefficients is lower than the highest of the "average" jump coefficients. On the average, the mean of five trials yields a score that is more valid than the mean of three. The use of two practice trials increases the validity of a single trial; the use of five practice trials increases the validity of the mean score of five trials, and possibly the validity of the mean score of three trials. These results are not very "clear-cut" because the probable errors of the obtained validity coefficients are large.

The "practice increment" scores are not correlated with the criterion ($r = .015$). The serial position of the best jump is also uncorrelated with the criterion ($r = .032$) and with the amount of the jump ($r = .17$). As a matter of interest,* the percentages of "best jumps" that occur in each trial are given in the fifth line of Table I. There is a slight tendency for "best" scores to pile up in the first jump but this is no more marked than the tendency to occur in the fifth trial, and less marked than the tendency to pile up in the last two trials. When plotted, these data reveal a trend toward more "best" jumps near the end of the series although chance fluctuations are pronounced. "Best jump in 5" of the first five trials occurs to the extent of 16 per cent in trials one and two, 20 per cent in trial three, 17 per cent in trial four, and 29 per cent in trial five. "Best of three" in the first three trials occurs to the extent of 34 per cent in trial one, 28 per cent in trial two, and 38 per cent

* McCloy[9] has stated that the first jump is usually the best. No data were given.

in trial three. In this three-trial series, the differences do not appear to be significant.

Fatigue, under the conditions of this experiment, does not seem to affect the validity of the test. The average coefficient for the odd-numbered trials (which were preceded by a 3-minute rest) is .408, and the average for the even numbered trials (½-minute rest) is .394. The differential effect is quite small. It would be expected to be largest in the last half of the series, but instead it completely disappears when only the last three pairs of trials are averaged.

DISCUSSION

The validity coefficients obtained in the present study evaluate the Sargent test as a measure of general athletic ability. All are positive and significant, but none are high. Probably they underestimate the real validity of the test somewhat because of the influence of the time interval between the test and criterion experiments. This was unavoidable since each subject required an individual practice period of about a half-hour, but allowance for this attenuation must be made. The coefficients do not disagree statistically with Cozens' results as to validity. Since McCloy's [9] and Van Dalen's [18] criteria were selected to emphasize the "power" aspect of athletic performance, their validity coefficients cannot be directly compared with those found in the present experiment; they were, however, higher to a significant degree. Carpenter,[2] using college women as subjects and a criterion not greatly different from McCloy's, reports a coefficient of .53 that is lower but in statistical agreement with McCloy's result for high school girls. It may be said, therefore, that there is confirmation that the Sargent test has a validity of the order of .48 to .59 as an index of general athletic ability, and validity of the order of .53 to .75 as an index of athletic "power." Van Dalen's validity coefficient of .81 is in statistical disagreement with McCloy's result; Van Dalen holds that his gain in validity is due to the use of adequate practice in both test and criterion. The results of the present study indicate that the discrepancy may actually be due to a "selection" factor arising from the use of the method of "best" scores.

The magnitude of the practice effect found in the present experiment might have been different if the trials had been distributed over several days, and if much larger amounts of practice had been given. This question seems to be primarily of theoretical interest; more than a half-hour of practice would not be very practical in an actual test situation, and even a two-day division of practice would materially affect one of the chief virtues of the test, namely its shortness and simplicity.

SUMMARY AND CONCLUSIONS

A simplified and improved recording device was used to obtain the Sargent jump test scores of 61 male university students. The data obtained, when analyzed as to mean performance for each trial of a 10-trial series, are found to show a practice effect. There is also evidence of a fatigue effect. The serial occurrence of "best" scores confirms these findings.

Both practice and fatigue seem to influence the reliability of the Sargent test. The validity (using general athletic ability as a criterion) is slightly but not significantly increased by practice. Fatigue (under the conditions of the experiment) does not affect validity.

Individual differences in the amount of improvement resulting from practice are smaller than individual differences in either initial or final test scores, and are uncorrelated with general athletic ability. This finding, in conjunction with the analysis of intercorrelations within the data, leads to the conclusion that practice can best be standardized by (*a*) allowing all subjects a uniform practice series of three trials before the test series; or (*b*) allowing no practice, and averaging the scores of five or more trials. The results of analysis of the validity coefficients are not inconsistent with this conclusion.

Scores based on the average of several trials appear to be more representative of individual ability in the Sargent test than "best" scores; they also tend to be more valid. Correlations between data obtained by the method of "best" scores cannot be interpreted at their face value, as they seem to contain a spurious factor.

"Best" scores are distributed throughout the practice series but tend to occur most frequently near the end. The relative occurrence in a given trial is conditioned by practice and fatigue if five or more trials are given. In a three-trial series, the occurrence is about the same in each trial of the three. The serial position of the "best" score is uncorrelated with athletic ability, and uncorrelated with ability in the test per se.

The reliability of the Sargent test ranges from $r = .77$ for a single unpracticed trial to $r = .97$ for the average of 10 trials. Its validity as a measure of general athletic ability ranges from $r = .39$ for a single unpracticed trial to $r = .48$ for the average of five trials preceded by a five-trial practice series.

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Speed and Accuracy in Learning a Ballistic Movement

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INTRODUCTION

THE purpose of this study was to determine the effect of placing emphasis on speed or on accuracy in the initial stages of the learning period of a ballistic movement.

A ballistic movement was chosen for this study because of its wide use in skilled movements. Whether the results of this experiment would be applicable to all ballistic movements may only be determined through further research to establish the consistency of the results within this type of movement.

This study was designed to establish a method of attack by which fundamental laws of motor learning might be discovered. The efficiency of teaching motor skills, in schools and factories alike, depends upon the determination of abstract laws of motor learning which may then be applied to specific movements.

It may be that a single law will not encompass all motor skills and that, as in mental learning, certain classifications may be necessary. If this is true, the grouping of movements in terms of laws of learning should also result from experiments of this type.

SURVEY OF RELATED STUDIES

Studies which have attempted to establish the relationship between accuracy and speed have yielded conflicting results. Some workers agree with Poppelreuter's "law" of practice,[1] that the optimum procedure is to retard speed of movement in the early stages of practice until a high degree of accuracy is reached and then gradually to increase speed. Others believe that speed is a part of form and should be emphasized from the beginning of the learning period. In general, publications in this field may be grouped as to the method of approach.[2] The method of attack which has yielded the least consistent results has been to establish the relationship betweeen speed and accuracy in one skill and then to consider this relationship to be true for the whole field of movement.

The other approach has been to attempt to establish a classification of movements. The need for such a grouping arises from the

1 John A. McGeoch, "The Acquisition of Skill," *Psychological Bulletin*, 26 (August 1929) 470.

2 L. D. Hartson, "Contrasting Approaches to the Analysis of Skilled Movement," *Journal of General Psychology*, 20 (April 1939) 263-293.

reasoning that inconsistency of results from the former approach is due to the fact that there is no consistent relationship between speed and accuracy in all movements, but that only within certain classes of movements certain relationships would remain constant. Stetson classified movements in the following manner:

1. Fixation, with antagonistic muscles contracted against each other.
2. Slow movement, with antagonists contracted but with uneven tension. The movement which can be changed at any point in its course.
3. Rapid movement—of two types—one with tension in all opposing muscle groups throughout the movement and the other in which the moving member is free of muscular tension in the middle of its course and is carried on by momentum. This movement was named by Richer "ballistic."[3]

Whether this classification has value in the psychological analysis of motor responses must be determined through experimentation showing the homogeneity in respect to rules of learning. In the present study the speed group used a ballistic movement from the beginning. The accuracy group started by using the second classification.

In a more recent study Peters and Wenborne[4] confirmed Stetson's work. They used a ballistic stroke to study the time patterns of movements of the hand over prescribed paths. They found that in a simple horizontal movement of the hand there was an increase in velocity up to the first half and a similar decrease over the second half. When this movement was repeated with "precision" as the primary aim, and with speed secondary, it was found that the two tasks interfered with each other and the stroke lost its uniformity. The velocity curve was more level than in the original experiment. This was called an "amorphous" movement.

With the exception of terminology, this classification is similar to that made by Stetson. It will be noticed that in both cases the grouping has been made in terms of the distribution of the time throughout the movement.

METHOD OF PROCEDURE

Apparatus.—Small rubber balls were projected at a given height by being rolled down an inclined trough and striking at an angle at the bottom. A gate controlled by a solenoid fed the balls into the trough at regular intervals. The electrical current which actuated the solenoid was controlled by a circuit breaker geared to a kymograph. Figure I illustrates the apparatus and its relationship to the path of the ball and the subject.

The equipment consisted of sponge rubber balls 1¼ inches in

[3] R. H. Stetson, "Mechanism of the Different Types of Movement," *Psychological Monographs*, 32 (1923) 18-20.

[4] W. Peters and A. A. Wenborne, "The Time Pattern of Voluntary Movements," *British Journal of Psychology*, Part I, 26 (April 1936) 388-406, Part II, 27 (July 1936) 60-73.

diameter and a wooden bat 9 inches in length and 1 inch wide. The striking surface of the bat was flat.

Equating the Groups.—The subjects were equated into two groups by ratings made by university physical education instructors. Only those students having three or more ratings were used for the experiment.

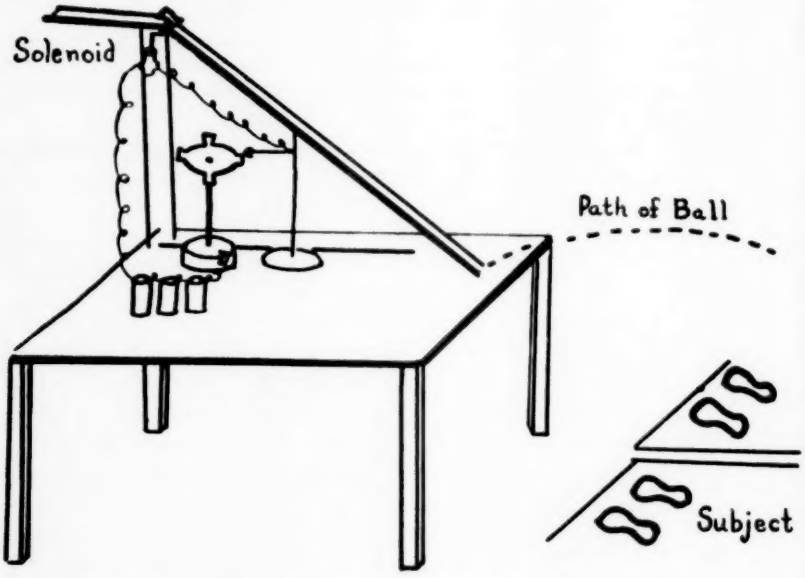

FIGURE I. Diagram of the apparatus and its relationship to the path of the ball and the subject.

Type of Movement Used.—The subject stood facing the apparatus to the left of the path of the ball. The bat was held in the right hand to the left of the subject's body preparatory to the stroke. The path of the movement was horizontal to the floor proceeding from the left to the right thus cutting across the path of the ball. A ball which was squarely hit travelled in a direction at right angles to its original direction. This movement was devised in order to eliminate insofar as possible the effect of previous practice.

Training Periods.—Two training periods a week for eight weeks were given. Each period consisted of seventy-five trials which were divided into sets of twenty-five with a minute of rest between each set. The instructions for the two groups varied only as to the point of emphasis. The accuracy group was instructed to retard the speed of the movement until a high level of accuracy was attained. The accuracy required before increasing speed was a score of forty-five successful hits in a single training period. The speed of the

movement was determined by the point at which the ball was in the trough when the swing was started. The maximum speed was determined by having the swing begin after the ball had left the trough. The speed group was to consider the element of speed as an integral part of the movement from the beginning of the training period.

Scoring.—Daily records of hits were kept and a learning curve was constructed on the card of each subject.

RESULTS OF THE EXPERIMENT

The data obtained were of three types, measures of accuracy, speed, and form. Accuracy was determined by the number of balls hit on each trial. A hit was scored each time a ball was hit to the wall. The speed and form of the strokes were determined through analysis of moving pictures taken after the last training period. Two strokes of each individual were used. A microfilm reader was used to analyze the pictures. Measurements were made to determine the distance the hand travelled from frame to frame. Since the camera runs at a uniform rate, frames were considered as the unit of time.

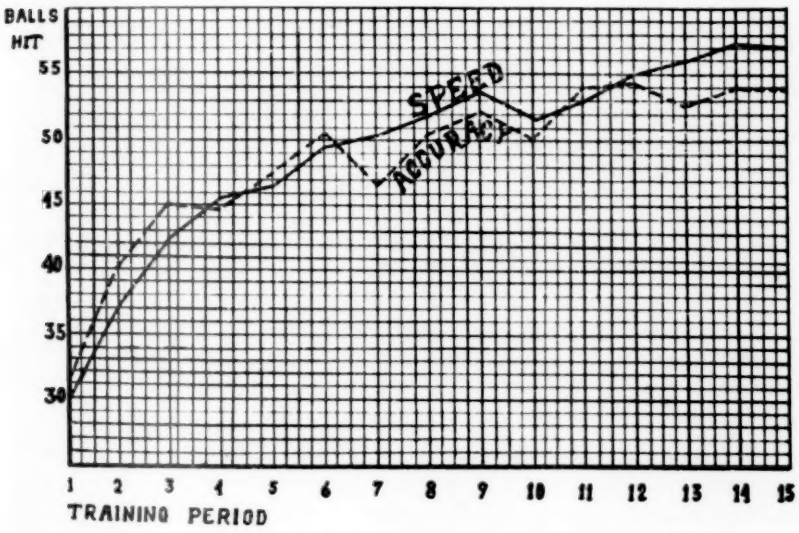

FIGURE II. Curve illustrating mean scores of accuracy group and speed group throughout the training period.

Measurement of Accuracy.—The scores of total hits were added for each group in each trial and the mean obtained. The group stressing accuracy was slightly superior in this respect for the first three periods. The greatest deviations occurred in the last two trials with the *speed* group superior in accuracy to the *accuracy*

group. Comparison of the differences in the scores in these periods are in Table I. The critical ratios are too small to conclude that emphasizing speed would always result in greater accuracy after a period of training. However, the data indicate that speed of the movement need not interfere with degree of accuracy. These data are illustrated in Figure II.

TABLE I

COMPARISON OF DIFFERENCES IN TOTAL NUMBER OF HITS IN FIRST THREE AND LAST TWO TRAINING PERIODS

N = 24

Period	Score A	σ	σM	Score S	σ	σM	d	σd	$\frac{d}{\sigma d}$
1	31.5	9.669	1.973	30.2	8.648	1.765	1.3	2.650	.491
2	40.3	10.395	2.122	37.1	9.533	1.950	3.2	2.883	1.110
3	45.0	9.640	1.968	42.4	7.480	1.528	2.6	2.490	1.044
14	54.0	6.510	1.329	57.2	6.700	1.368	3.2	1.910	1.675
15	54.0	7.820	1.596	57.1	6.440	1.315	3.1	2.070	1.497

Coefficients of reliability obtained through correlation of two successive trials ranged from .519 to .776. These relatively low correlations would be expected because of the homogeneity of the group, the degree of difficulty of the skill, and the fact that it is a learning situation with individuals progressing at different rates.

In order to get a truer picture of reliability and eliminate insofar as possible the learning situation, the scores of the fifteenth trial were recorded in thirds, *i.e.*, the number of balls hit in each group of twenty-five. The first third was eliminated because of warm-up variability. The second and third groups were then correlated with each other. Group *A* had a correlation of .591, and group *S* of .748. These, when treated by means of the Spearman-Brown prophecy formula (that is, to increase the length of the test in order to make it comparable to a total trial of seventy-five balls), increased to .799 and .825 respectively.

Measurement of Speed.—The speed of the strokes was determined through analysis of moving pictures taken after the last training period. The scores obtained in this way were the number of millimeters the hand moved from frame to frame. Since the camera runs at a uniform rate, frames were taken as a unit of time. The speed of the movement of each individual was computed by dividing the length of the stroke by the number of frames. The mean length of the stroke of the two groups was practically the same. Neither was there a significant difference in the speed of the movements of the two groups at the end of the training period.

Measurement of Form.—Form of the movement was also determined from the moving pictures of the strokes. A time pattern

was computed for each group by averaging the distance covered from one frame to the next. Figure III illustrates the time curves of the two groups constructed from these data. It will be noticed that the speed group averages a greater speed in the middle of the stroke than the accuracy group. This shows that a more truly ballistic movement is being used by the speed group. On the other hand, the movement used by the accuracy group would seem to re-

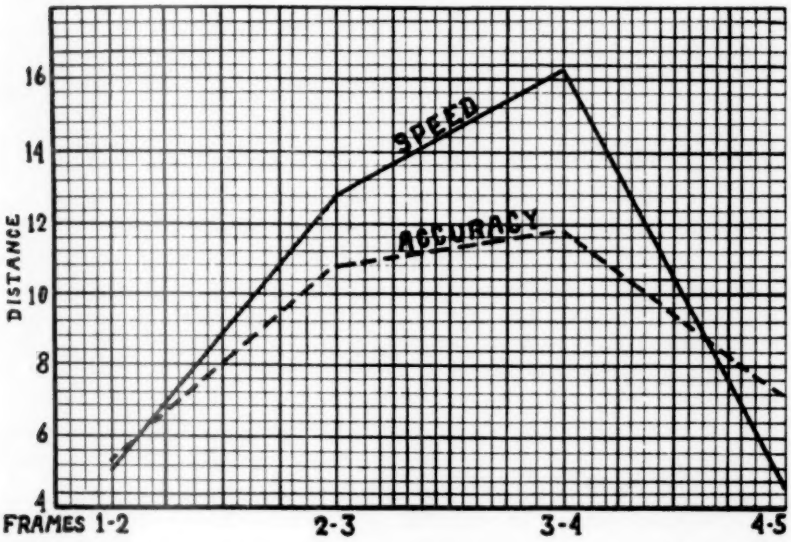

FIGURE III. Graphic representations of the time patterns of accuracy group and speed group after the final training period.

semble Stetson's first type of fast movement, one in which no momentum is gained but with tension in opposing muscle groups.

Consideration of the critical ratios reveals that the most significant difference is in the distance travelled between the third and fourth frames. The ratio in this case was 3.370. Table II shows these relationships.

TABLE II

COMPARISON OF MEAN SPEEDS BETWEEN EACH OF FIRST FIVE FRAMES

Frame	Mean Speed *A*	σ	σM	Mean Speed *S*	σ	σM	d	σd	$\frac{d}{\sigma d}$
1-2	5.234	2.050	.435	5.140	1.624	.450	.094	.626	.150
2-3	10.823	3.893	.830	12.888	4.026	1.116	2.065	1.390	1.485
3-4	11.800	3.696	.788	16.285	3.874	1.074	4.485	1.331	3.370
4-5	7.016	3.923	.830	4.796	2.080	.577	2.220	1.010	2.200

SUMMARY AND CONCLUSIONS

The experiment attempted to demonstrate the effect of placing emphasis on speed or on accuracy in the initial stages of a training period of a ballistic movement. Two equated groups were given fifteen training periods at the rate of two a week. One group was instructed to emphasize accuracy and increase the speed of the swing only when the accuracy was high. The other group aimed at speed from the beginning of the training period.

These two groups were compared at the end of the series of trials for the following factors:

1. *Accuracy.*—The results indicate that the group emphasizing speed developed accuracy even to a greater extent than the group which made accuracy of stroke the primary aim from the start of the experiment.

2. *Speed.*—The total speed of the strokes of the two groups in the final training period was practically the same.

3. *Form.*—The distribution of the speed throughout the stroke was significantly different for the two groups. The accuracy group had a more uniform distribution. On the other hand, the group that had emphasized speed from the start showed a definite gain in momentum in the middle of the stroke.

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The Implications of Sickness Records of Public School Pupils

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INDUSTRY as well as education must consider daily attendance and physical fitness along with many other factors that are instrumental in the orderly production of work. School attendance and study are, in a sense, preparation for later responsibilities. Sickness, as a major cause of absence from work, in adult life, is also the leading factor in absence from school. It is responsible for a very large per cent of the loss of time and results in less efficient work in both school and industry, not to mention the financial loss involved.

Nearly everyone accustomed to working with groups of individuals knows that the common cold and other respiratory disturbances are major causes of sickness and absence from routine duties either in school or business. Perhaps it is also common knowledge that seasonal trends show the presence of more sickness during the winter months when the temperature is lower, precipitation higher, and there are fewer hours of sunlight.

Industry has found that good health is an asset and relies on approved medical examinations and health records to insure the efficient selection and placement of personnel. Public health authorities, school health departments, and in some cases, attendance departments, keep daily, monthly, and seasonal records of certain types of sicknesses, such as contagious diseases. At present, health records often include absences caused by accidents as well, although many communities keep these on the type of form recommended by the National Safety Council.

Records of the many types of sicknesses affecting public school pupils and their relative importance, as they affect the attendance records of boys and girls, are not as accessible as might be expected. Data showing the causes of absence and their effects on attendance during the various seasons of the year and at the various age and grade levels were assembled and tabulated by Mr. Selwyn D. Collins.[1]* These records include data covering a period of several years in a number of communities in the United States. Dr. W. W. Patty and Paris John VanHorn,[2] in a study of the "Health of the High School Athlete," kept a record of the types of sicknesses occurring among some 18,825 high school athletes participating in the major

* Superior figures refer to numbered Bibliography at end of article.

competitive sports in 375 Indiana high schools in 1934-35. In these two studies, although they had different objectives, the common cold was found to outnumber all other sicknesses, and influenza and grippe were next.

The findings of these studies and the statement of Dr. Harold S. Diehl[3] that "the common cold is the commonest of all human ills" are based on records of actual cases of sickness among large numbers of individuals from a variety of communities and situations. Additional information, that is, a record of the actual sicknesses occurring in a public school system during a school year, substantiates the findings already mentioned and also establishes the relative liabilities for age and grade groups, seasonal variations, and sex differences. In a study by the writer,[4] sickness records of approximately seven thousand white pupils were assembled and classified for the period from September first, 1938, to June first, 1939. This group represented 20 per cent of the white enrollment of the Louisville Public Schools for that period. There was an average of 538 pupils observed in each grade, kindergarten through the twelfth, and the monthly, seasonal, and total findings were classified as to age, sex, and seasonal tendencies.

In general, the majority of illnesses causing absence and the resulting total of days lost for each sickness were caused by ten major sicknesses for both boys and girls and are practically the same for all grades throughout the school year. Approximately 86 per cent of all absence from sickness was due to the following causes:

TABLE I

NUMBER AND PER CENT OF PUPILS ABSENT DUE TO TEN MOST COMMON SICKNESSES

Sickness	Number	Per Cent
Colds	8,917	45.98
Sick	2,173	11.14
Sore throat	1,564	8.06
Upset stomach	1,348	6.98
Influenza	998	5.15
Teeth	465	2.40
Headache	404	2.08
Ears	315	1.65
Dysmenorrhea	272	1.40
Tonsilitis	267	1.39
Others	2,680	13.81
TOTAL	19,403	100.00

The differences that appeared at the various age and grade levels were those of greater susceptibility to the listed sicknesses and the resulting loss of time. In this respect, there is evidence that pupils in the kindergarten and elementary grades lose a greater proportion of time per observed pupil than those in the secondary grades. There is a gradually decreasing loss of time per observed pupil from the

kindergarten, where there was an average of .60 absences and an average loss of 3.80 days, to the twelfth grade, where there was an average of .26 absences and an average loss of 1.65 days per absence.

The average number and length of absences per observed pupil varies according to the age and grade level. There are two grades, however, the fourth and eighth, that do not conform to the descending scale of absence and loss of days from the kindergarten through the twelfth grade. The average age of the fourth grade is 8½ to 9½ years, and the average age of the eighth grade is 12½ years to 13½ years. At these two age and grade levels, physiological development probably plays an important part in determining the ratio of absence.

There was also a noticeable difference in the number and length of the average absences of boys and girls. In numbers observed, the girls total amounted to 47.44 per cent, but their total number of absences was 54.41 per cent. This indicates a larger number of individual absences for girls for the period of observation. Comparing the average number of absences for the observed group, we find that there were .26 absences for boys and .36 absences for girls, a clear indication of the greater amount of absence for girls. As for the average length of absence, girls do not lose as long a period of time per individual absence. The records indicate an average loss per absence for the period of observation of 2.10 days for girls and 2.27 days for boys.

It is an accepted fact that there is apt to be more sickness and loss of time from school during the winter months in localities where the temperature, precipitation, and hours of sunlight vary, as they do in the average mid-western community. Actual records serve to substantiate this knowledge and provide a sounder basis for its acceptance.

In the group observed in Louisville, Kentucky, there were approximately 7,196 individual pupils under observation each month from September, 1928, to June, 1939. The number of absences and the number of days lost each month, due to sickness, show the monthly, seasonal, and total trends.

TABLE II

NUMBER OF ABSENCES AND NUMBER OF DAYS LOST BY MONTHS

Month	Absences	Days Lost
September	1,181	2,356
October	1,862	3,731½
November	2,145	4,212¼
December	2,198	4,612½
January	2,390	5,376
February	3,093	6,975½
March	3,241	8,517½
April	1,895	3,994½
May	2,039	3,835½
TOTAL	20,044	43,611¼

The winter season had the largest number of absences and number of days lost although March was the month in which the peak of sickness was reached. This is clearly indicated by the number of absences and number of days lost. One additional factor, the severity of sickness in each month as shown by the average loss of time per absence, also follows the general seasonal trend.

TABLE III
AVERAGE LOSS OF TIME PER ABSENCE BY MONTHS

Month	Days Lost
September	1.99
October	2.00
November	1.96
December	2.09
January	2.25
February	2.26
March	2.63
April	2.11
May	1.88

The steady increase in the average loss of time per absence from September through March follows the corresponding increase in number of absences and number of days lost and is further indication of the increasing severity of individual illness throughout the winter season and the month of March. This period, during which sickness, absence, and the severity of individual illness all increase, is followed by a shorter period of two months, April and May, during which the temperature rises, there are more hours of sunlight, and less precipitation. The amount of sickness decreases rapidly in April and is fairly even for May, but it does not return to the September level. School closes with a sickness load that nearly equals the November record. Apparently, pupils do not have the same degree of resistance in April and May that they had in September and October.

A study of sickness records of public school pupils, limited by definite restrictions as to locality and time, is interesting from the viewpoint of facts revealed, although these facts cannot be applied generally or specifically to other communities until they are verified by additional scientific evidence. However, certain tendencies, such as seasonal trends of sickness, the actual causes of sickness, and their age and grade location, may be basic data for local health authorities.

The amount of sickness among public school pupils seems to increase from the opening day of school in September until sometime in March. It decreases rapidly in April and, to some extent, in May but does not return to the average September level. Whether this is the result of lower temperatures, lack of sunshine, and increased precipitation, or to the confining quarters of home and school during the winter months, or both, is an unanswered question. The

fact remains that despite our present health programs, supervision of facilities, and various efforts to preserve and improve the health of all pupils, there are certain influences or factors that are a drain on pupil resistance to certain common sicknesses.

The apparent difference in liability to sickness between boys and girls, that is, the greater number of individual absences among girls and the fact that their absences were of shorter duration than those of boys, might well be the result of their early care and training. It is logical to suppose that the girl may be slightly less inclined to take chances with minor illnesses and may also receive more attention in the home as well as at school.

As pupil age and grade levels increase, the liability to sickness decreases. Only two grades, the fourth and eighth, did not conform to the general pattern. At these two levels there was more than the average amount of sickness per observed pupil than the normal rate of decline from the kindergarten through the twelfth grade would indicate. Since there was no evidence of any new or special sicknesses at these grade levels beyond the tendency to have a greater number of individual absences, this characteristic may well be traced to the stages of physiological development in these two groups. Good health technique might call for a careful study of the specific needs of the pupils in these two grades especially as to habits of diet, exercise, and relaxation. The home and school can well afford to cooperate when planning a study of this kind.

Conclusions as well as recommendations that might be inferred from the various implications of these records of pupil sickness are restricted, of course, by the realization that only certain characteristics and trends were observed and these in specific localities and for certain periods of time. Nevertheless, it is important that facts, not suppositions, support the major premises of all sound health programs and these facts be constantly checked for possible variations.

School and community health authorities, working with available research facilities, can obtain an accurate seasonal or yearly record of general health conditions and needs in a given community and use this information when formulating their health programs. In the Louisville study some ten sicknesses caused approximately 86 per cent of all absence due to sickness, and sickness was responsible for approximately 80 per cent of all school absence. Colds alone caused 45 per cent of all absence due to sickness and colds plus respiratory diseases caused over 60 per cent.

Administration, as the guiding influence in education, can well afford to cooperate with the accredited medical and dental associations as well as local and state health departments so that the combined resources of public and private health agencies may be utilized

as an organized force for healthful living throughout a community. There are approved methods of survey and measures of accuracy by which a community can determine its general health status. Improvement is apparent in the fields of supervision, prevention, and correction, but the incidence of sickness and the need of further research, even in the matter of the common cold, is very evident from the records of our schools, homes, and industries.

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The Relationship Between Measures of Motor Educability and the Learning of Specific Motor Skills

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THE term *motor educability* was introduced into the literature of physical education by McCloy in 1934 and was defined as "the ability to develop high skill quickly." [23] * Since that time there have been published a number of studies in the measurement of motor educability and the relationship of this quality or factor to other motor factors and to performance. The progress of this research has been viewed with interest by many in our profession; the concept of motor educability is a valuable one. A test of motor educability which would analyze accurately the ability to learn, or the aptitude of the individual for learning, would contribute to a better understanding of physical performance and would provide an effective tool for the administration of the physical education program.

It seems certain that the term *motor educability* has been interpreted somewhat differently in the various studies which have been published. Although all definitions imply a close relationship between motor educability and learning, only one study has utilized a learning criterion in an effort to validate an "educability" test. The relative value of the various tests as measures of "motor educability" has not been experimentally determined. Studies have been confined in general, to the isolation and definition of the factor of motor educability through empirical or statistical means, to comparisons between two types of tests of motor educability, and to the relation of these tests to achievement, not to the ability to learn.

It was with the belief that a better understanding of the concept of motor educability could be obtained that the present study was undertaken. The purpose of this study was to determine the relationship between the Brace, the Iowa Revision of the Brace, and the Johnson tests, which have been designated as measures of "motor educability," [25 p. 20] and the achievement and learning by high school girls of specific motor skills in the three activities of basketball, volleyball, and baseball.

* Superior figures refer to numbered Bibliography at end of article.

One hundred ninety-five girls in a four-year senior high school in California served as subjects for this study. These girls were the students of the junior author. All girls who were physically able to participate in the regular physical education program of the school were included in the study. The girls ranged in age from thirteen through eighteen years and in experience from no participation in some of the physical activities to twelve years (seasons) of experience in one or more activities. All girls reported some previous experience in at least one of the sports tested.

An intensive program of measurement was included as a part of the regular girls' physical education program during the spring semester of 1939. The tests selected for the experiment were representative of the activities taught in class, sampled all possible techniques, and were given as an integral part of the regular program. The physical education course for the semester of testing was of the "block" or seasonal type in which one activity was scheduled daily for a number of weeks. During the weeks of teaching basketball, volleyball, and baseball, the program was organized so that each girl participated in the game for two-thirds of the class period and took tests during the remaining one-third of the time.

"Motor educability" was measured by the three designated tests of this factor: the Brace Scale of Motor Ability Tests,[4] the Iowa Revision of the Brace Test (for Senior High School Girls),[22] and the Johnson Physical Skill Tests for Sectioning Classes into Homogeneous Groups.[19] The Brace and Iowa-Brace tests were administered outside of school hours; the Johnson test was given in the regular class period. In all tests, each subject performed individually and was scored by the administrator. Scoring of the test items in this study was strict; good form in performance was demanded for success in the events of the Brace and Iowa-Brace tests, and precise performance of the exercises of the Johnson test was required.

The reliability of the Brace test was .7421 ± .0230, the reliability of the Iowa-Brace .6111 ± .0320, and the Johnson .6111 ± .0320. Since these tests do not have parallel forms and could not well be repeated, these reliability coefficients were obtained by correlating the comparable halves of the Brace and Iowa-Brace tests (as equated by Brace and McCloy) and estimating the reliability of the whole test by means of the Spearman-Brown formula. The "split-half technique" was used in the Johnson half-test reliability.

Scores in the three "educability" tests were complete for 162 cases. To determine their interrelationships, each test was correlated with each of the other two tests. The results are shown in Table I.

TABLE I

INTERRELATIONSHIPS OF "MOTOR EDUCABILITY" TESTS*
(Number = 162)

	Brace	Iowa-Brace	Johnson
Brace		.7664 ± .0217	.2018 ± .0512
Iowa-Brace	1.0000 ± .0000		.4817 ± .0410
Johnson	.3019 ± .0485	.7897 ± .0196	

* Lower half of table presents coefficients corrected for attenuation.

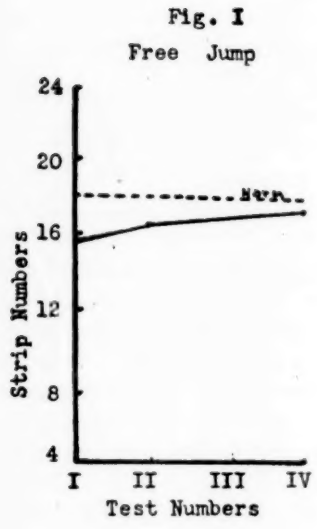
It may be seen that there is a fairly high relationship between the Brace and Iowa-Brace tests, substantial relationship between the Iowa-Brace and Johnson tests, but only a very slight relationship between the Brace and Johnson tests. Evidently these three tests of "motor educability" are not measures of the same ability to the same degree.

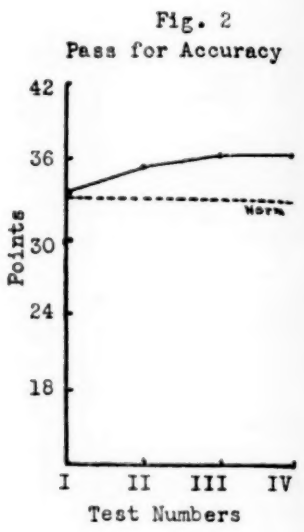
When the coefficients of correlation were correlated for attenuation, it became apparent that the Brace and Iowa-Brace tests are measures of the same ability and might be expected to correlate perfectly with each other if errors of measurement could be eliminated. The Johnson test, on the other hand, seems to sample somewhat different functions.

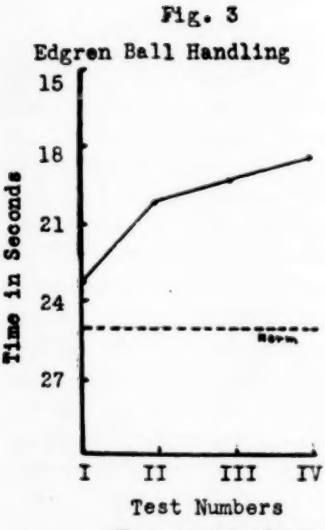
Achievement and learning of basketball, volleyball, and baseball skills were measured by frequently repeated achievement tests.* The techniques which should be sampled by the achievement tests were determined by analyses of the games. Eight basketball tests were administered from three to seven times each over an eight-week period. Two volleyball tests were administered five times each over a three-week period. Five baseball tests were administered from three to six times each over a five-week period. The first series of tests in each sport was completed before any of the subjects received instruction or practice in the game.

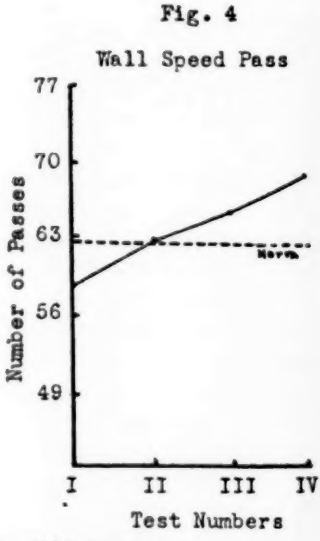
Since specific instructions and practice in all activities were given between repetitions of tests, the correlations between first and second trials are not, strictly speaking, reliability coefficients. (For correlations, see appendix.) The consistency of mean results upon repetition of tests is shown in Figures 1 - 14. In order to increase the reliability of the measurement and so obtain as stable criteria as possible, all achievement test scores for one sport were combined. Raw scores were converted into T-scores and these scores were added. The total scores which were obtained before the subjects were given instruction and practice in the game were named "Total Basketball I," "Total Volleyball I," and "Total Baseball I." The scores from the final testing in each sport were labeled "Total Basketball IV," "Total Volleyball V," and "Total Baseball V." The interven-

* A list of the achievement tests used in this study is included in the Appendix.









FIGURES 1-4. Results of basketball achievement tests.

ing series of tests were similarly distinguished. These scores represent the achievement of the subjects at specific intervals.

In analyzing the problem, there appeared to be three different measures of learning which might be used to study the "educability" of the subjects. The initial learning or change which takes place at

the beginning of the season may be attributed in part to neuromuscular adjustment to the activity and in part to a more thorough understanding of the procedure and mechanics of the test situation. In any case the difference between the first and second total test scores may be taken as a measure of quick adjustment. After the subject has become familiar with the nature of the activity, the learning brought about as a result of continued practice may be considered primarily motor. The difference between the second and last test scores has been used, then, as the criterion of motor learning. A combination of these two measures or the change from the first to the last test series includes the total learning for the season. Thus three learning scores were computed for each subject in each of the three sports.

To find the relationships of the measures of "motor educability" to the learning of the subjects in this study, the Brace, Iowa-Brace, and Johnson tests were correlated with these difference scores. In addition, correlations between the three tests of "motor educability" and the first and last test series of each sport were computed to determine the relationships between "motor educability" and the skill status or achievement of the subjects at the beginning and end of each sport season. These results are presented in Tables II, III, and IV.

TABLE II

RELATIONSHIPS BETWEEN MEASURES OF "MOTOR EDUCABILITY" AND ACHIEVEMENT AND LEARNING IN BASKETBALL

	Brace	Iowa-Brace	Johnson
Total I	.3617 ± .1072	.3117 ± .1113	.2709 ± .1142
Total IV	.6565 ± .0695	.5371 ± .0872	.3061 ± .1113
Diff: II-I	.5045 ± .0924	.2456 ± .1155	.0724 ± .1226
Diff: IV-II	−.1990 ± .1187	−.2913 ± .1128	−.2015 ± .1182
Diff: IV-I	.2934 ± .1128	.1219 ± .1214	.0456 ± .1228

Of the correlations computed for the basketball study (Table II) only three were wholly significant, i.e., four times their probable errors. The Brace test shows a fair relationship to the criterion of initial learning (Total Basketball II-I) and so may be said to indicate to some degree the ability of the subjects to develop skill quickly. Both the Brace and Iowa-Brace tests are correlated somewhat with final achievement (Total Basketball IV). The Johnson test shows no significant relationship with any measure studied.

TABLE III

RELATIONSHIPS BETWEEN MEASURES OF "MOTOR EDUCABILITY" AND ACHIEVEMENT AND LEARNING IN VOLLEYBALL

	Brace	Iowa-Brace	Johnson
Total I	.2209 ± .0677	.3004 ± .0647	.1916 ± .0686
Total V	.2395 ± .0670	.2949 ± .0647	.2260 ± .0674
Diff: II-I	.1218 ± .0701	−.0323 ± .0711	.0441 ± .0710
Diff: V-II	−.0475 ± .0709	−.0355 ± .0710	−.0236 ± .0711
Diff: V-I	0039 ± .0711	−.0305 ± .0711	.0426 ± .1710

All correlations of the "motor educability" tests with the volleyball data are low (Table III). Only two are four times their probable errors; these are the correlations between the Iowa-Brace test and Total Volleyball I and the Iowa-Brace test and Total Volleyball V. Thus, the Iowa-Brace shows a slight tendency to correlate with the skill level of the subjects both at the beginning and end of the teaching period. Although the correlation between the Brace test and initial learning (difference, II-I), is very low and of doubtful significance, it should be noted that this relationship is the largest of any between a learning criterion and an "educability" test.

TABLE IV

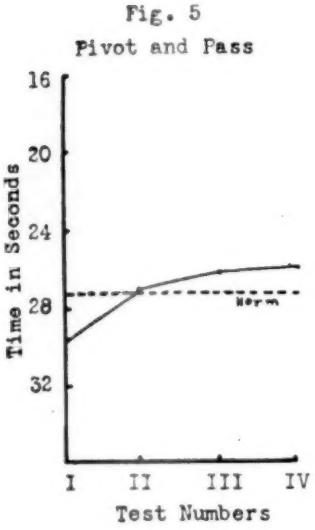
RELATIONSHIPS BETWEEN MEASURES OF "MOTOR EDUCABILITY" AND ACHIEVEMENT AND LEARNING IN BASEBALL

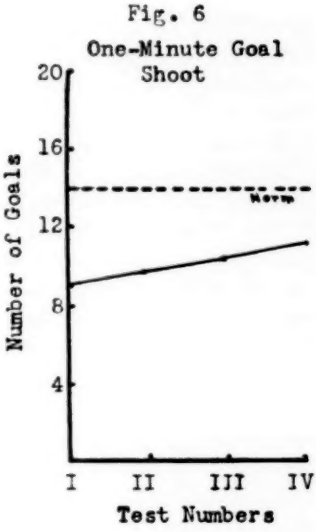
	Brace	Iowa-Brace	Johnson
Total I	.3923 ± .0738	.3392 ± .0770	.4046 ± .0724
Total V	.3809 ± .0745	.2834 ± .0802	.2689 ± .0807
Diff: II-I	.1120 ± .0860	.1311 ± .0856	−.1913 ± .0840
Diff: V-II	.0451 ± .0869	−.0269 ± .0870	.1724 ± .0846
Diff: V-I	.1463 ± .0851	.1054 ± .0860	−.0274 ± .0870

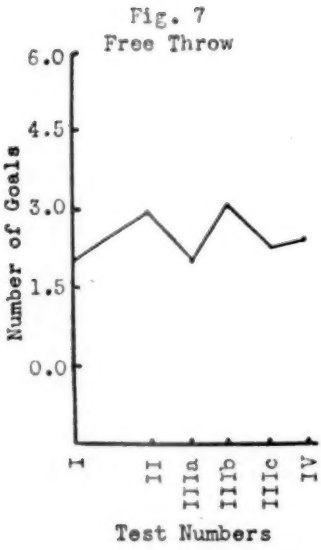
In general, the baseball correlations (Table IV) are higher than the volleyball correlations but are more similar to the latter than to those of basketball. The three tests of "motor educability" correlate low but significantly with Total Baseball I, and the relationship of the Brace test to Total Baseball V is similarly significant. All three tests tend to correlate slightly with the skill level of the subjects at the beginning and end of the baseball season, but no one test shows a significant relationship to any criterion of learning. The Brace test is more stable in its relationships to all items studied, both to the learning and to achievement, than are the Iowa-Brace and Johnson tests.

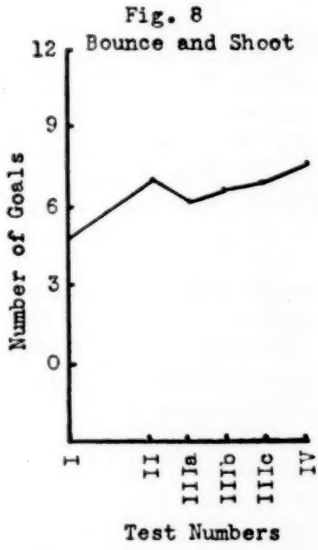
The degree of relationship of the three tests of "motor educability" to the learning and achievement criteria seems to be proportionate in a rough way to the number of weeks of participation, and, in addition, to the number of achievement tests used. In basketball, with eight weeks of participation and eight different achievement tests, the highest correlations were found. In baseball, with five weeks of participation and five achievement tests, the order of correlation was somewhat lower, and in volleyball, which covered a period of three weeks and in which two different achievement tests were used, the lowest order of correlation was noted. This finding suggests that the degree of relationship is a function of both length of the practice period and reliability of the criteria.

In summary, the Iowa-Brace test was found to be most consistent throughout in relationship to the skill level of the subjects at the beginning of each season. The Brace test tends to be most closely









FIGURES 5-8. Results of basketball achievement tests.

related to final achievement. In the relationships to initial learning (differences between the first and second series of tests), the Brace test is highest in basketball and volleyball but is equaled by the

Iowa-Brace in baseball. All correlations are very low and in most instances not significant. Negative relationships are the rule in the correlations of all "educability" tests with the criterion of "motor" learning (IV-II or V-II). These negative relationships indicate that those individuals who are the best early in the season make the least progress, i.e., achieve less. This may be attributed to the fact that these individuals have more nearly reached their limit of development and so have less possibility for improvement. The Brace test shows the highest relationships with total learning (IV-I or V-I) in basketball and baseball. The order of the correlations is small and especially in volleyball is too low to be of significance.

From this analysis of the results of the correlations of the three tests of "motor educability" with the criteria of achievement and of learning, the conclusion may be drawn that the highest relationships are shown by the Brace test, the second highest by the Iowa-Brace test, and the lowest by the Johnson test. However, the degree of relationship in all cases is too low to obtain reliable prediction of any one criterion.

II

Motor educability has been defined frequently as the ability to learn *new* skills easily. Since many of the subjects in this study reported previous experience in the game skills tested, the number of inexperienced subjects was not sufficient for reliable statistical study. The mean scores of these latter subjects were compared with the means of the whole group and with those of the most experienced subjects in order to examine the effect of experience on achievement and learning.

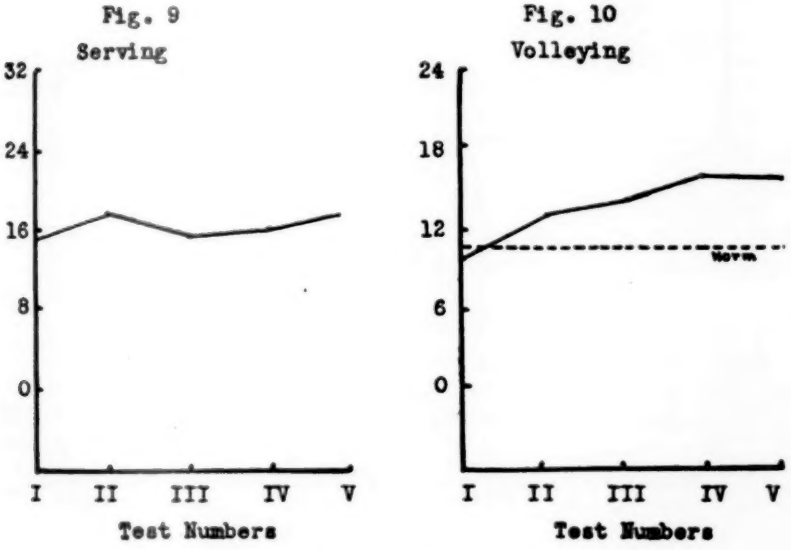
In the basketball comparison, the inexperienced group was slightly below the group average and markedly below the experienced group in scores on the Brace, Iowa-Brace, and Johnson tests and in the mean scores of Total Basketball I and IV. However, the inexperienced group showed the greatest improvement in learning as measured by the differences between I and II, II and IV, and I and IV. The mean score of the inexperienced group, after this one season of participation, was above the mean score of the experienced group at the beginning of the season and was almost equal to the mean of the whole group at the end of the season.

In volleyball, the "educability" test scores of the inexperienced group were inferior to those of the experienced group but approximately equal to those of the total group. The experienced group here, as in basketball, was superior in achievement but showed less gain than the inexperienced group.

In baseball, the inexperienced group was inferior to both experienced and total groups in all "educability" measures and in achievement scores. The inexperienced group was slightly superior to the

total group in all measures of learning, but only in the percentage of improvement between II and V did the former exceed the experienced group.

In order to study further the relationships between the tests of "motor educability" and achievement and learning in new skills, rank order coefficients of correlation between "educability" scores of the inexperienced groups and learning and final achievement in the three sports were computed. The samples were so small that the findings must be interpreted with caution.



FIGURES 9-10. Results of volleyball achievement tests.

The order of relationships with all measures were similar for both the Brace and Iowa-Brace tests. Apparently these tests measure to a small degree the "ability to learn new skills quickly" but are inversely related to "motor" learning. The most consistent relationship shown was that of the Brace and Iowa-Brace with final scores in all sports. Both measures may be said to indicate roughly the level of ability attained over a period of time.

The correlations of the Johnson test with all measures of achievement and learning were negative in basketball, low and in general positive in baseball, and positive and somewhat higher in volleyball. This trend suggested a negative relationship between the Johnson score and length of season, number of achievement tests, and time interval between test series. However, this negative relationship was not sufficiently marked to be of practical value.

Fig. 11

Overhand Throw and Underhand Pitch for Accuracy

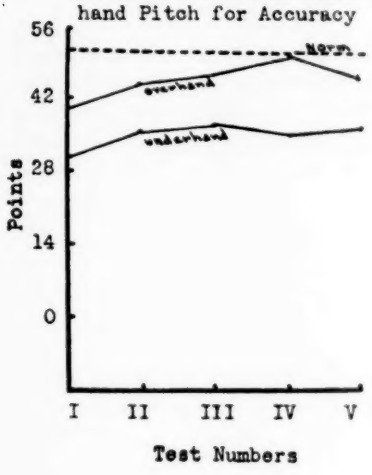


Fig. 12

Baseball Catch

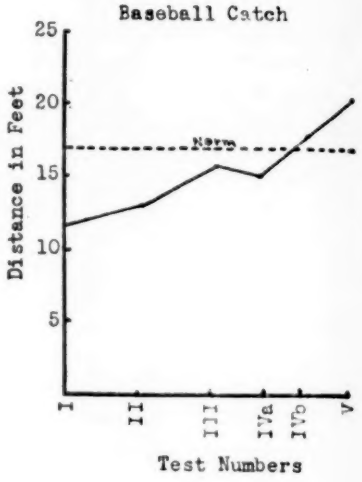


Fig. 13

Throw for Distance

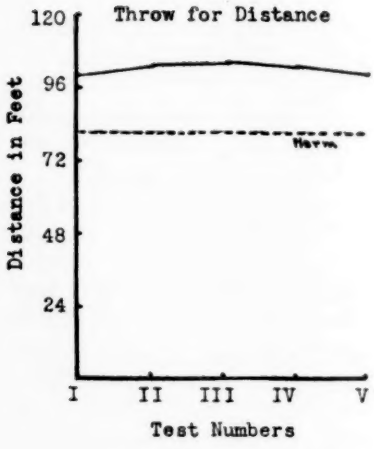
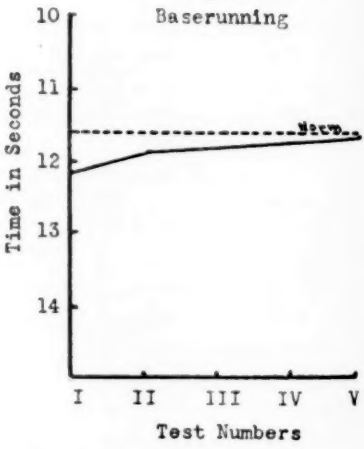


Fig. 14

Baserunning



FIGURES 11-14. Results of baseball achievement tests.

III

Comparisons were made between groups scoring more than one standard deviation above and below the mean in the Brace, Iowa-Brace, and Johnson tests to show the differences in learning and achievement of the two extreme groups. It was found that in the extremes of the range, all three measures of "educability" were ade-

quate to differentiate groups according to initial and final ability. The mean difference between the high and low scoring groups was most substantial in the Brace comparisons, somewhat less so in the Iowa-Brace, and smallest in the Johnson. According to the Iowa-Brace and Johnson test selections, the low scoring groups in the last test series reached or exceeded the skill level which the high scoring group had attained at the beginning of the seasons; the Brace high scoring group, on the other hand, displayed a level of skill at the beginning of each season which was not reached or approximated by the low scoring group in the last test series, and the difference between the two groups increased substantially during the entire period.

The high scoring group selected by the Brace test was superior in all sports to the low scoring group in initial learning (II-I). For this same period of learning the Iowa-Brace high group exceeded the low group in increase in mean scores in all activities. The relation between high and low Johnson groups was not consistent throughout.

The results were less clear cut for the period of "motor" learning (II to end) and for the total learning. The low group according to all three tests tended to exceed the high group in the amount of change from the second to the last test series, but this was not invariably true.

It would appear, then, that even in the extremes of the range only the Brace test can distinguish accurately the ability to make quick adjustments (II-I), and that no measure studied will invariably distinguish those who learn most from those who learn least over a period of time.

Thus, it may be concluded that no test of "motor educability" studied measured accurately the ease with which the subjects in this study learned new skills or relearned old ones in basketball, volleyball, and baseball in regular physical education classes. In general, the Brace test showed the highest relationships to the criteria of learning utilized to study the "educability" of the subjects. Of the three "educability" tests, the Brace measured most accurately, and the Iowa-Brace to some degree, the ability of the subjects to attain a relatively high level of skill over the period of participation in the activities studied.

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APPENDIX

BASKETBALL ACHIEVEMENT TESTS

Wall Speed Pass—See reference 35, p. 14.
Free Jump—See reference 35, p. 20.
Edgren Ball Handling—See reference 35, p. 21.
Pivot and Pass—See reference 7.
Bounce and Shoot for Goal—The test layout is as follows: On either side of the goal two marks are drawn on the floor, 15 feet from the midpoint of the court under the backboard, and at 45-degree angles to the backboard.

From the mark on the right of the basket the subject bounces toward the basket and shoots immediately. After five trials from the right, five are taken from the left, and five from the center, the starting point at the free throw line. The score is the number of baskets made in the fifteen trials.

One-Minute Basketball Throw for Goal—See reference 7.
Pass for Accuracy—See reference 7.
Free Throw for Goal—The subject, with both feet behind the free-throw line, attempts ten successive free throws. The score is the number of baskets made in the ten throws.

VOLLEYBALL ACHIEVEMENT TESTS

Serving for Accuracy—See reference 13.
Volleying for Accuracy—See reference 7.

BASEBALL ACHIEVEMENT TESTS

Overhand Throw for Accuracy—See reference 7.
Underhand Pitch for Accuracy—See reference 7.
Baseball Catch—See reference 7.
Baserunning—See reference 7.
Throw for Distance—See reference 7.

CORRELATIONS OF FIRST AND SECOND TRIAL SERIES OF ACHIEVEMENT TESTS

Basketball (Number = 120)			
Ball Handling	.8281	Goal Shoot (1 minute)	.6108
Bounce and Shoot	.3345	Pivot and Pass	.5543
Free Jump	.9121	Throw for Accuracy	.7260
Free Throws	.1350	Wall Speed Pass	.7513
Volleyball (Number = 133)			
Serve	.7373	Volley for Accuracy	.7891
Baseball (Number = 130)			
Baserunning	.4801	Overhand Throw	.4366
Catch	.4050	Underhand Pitch	.4054
Distance Throw	.9084		

A Study of the Relationship that Exists Between Physical Skill as Measured, and the General Intelligence of College Students

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PROBLEM

In the integrated personality it would seem logical to assume that it might be possible to establish a definite relationship between the several factors that go to make up the whole person. With certain of the tools at our disposal, namely, the several devices used in the attempt to measure the various entities of which the human being is made, we checked certain elements that existed between these situations and correlated the results. As the work progressed, we were struck by the fact that the tests that were administered apparently did not measure what they claimed to measure. The psychological test, we felt, did not measure that subtle entity called general intelligence. The evidence at hand seemed to indicate that this test just demonstrated that bright students did better in it than dull ones. General intelligence when measured by achievement (academic grades) showed a relatively low correlation with these psychological test scores. Also, the instrument that was used to measure physical skill did not serve as a prognostic guide, nor were the two factors, intelligence and skill, significantly related.

METHOD

In order to shed some light upon certain phases of this problem, 310 college freshmen (both men and women) were given a test to determine their academic status. This test is one that was prepared for the American Council on Education by L. L. Thurstone and Thelma Gwinn Thurstone, and is designed for College Freshmen.[1] It is purported to be a test of scholastic aptitude, and is divided into two parts, Linguistic and Quantitative. The Linguistic Test is based upon familiarities with Same-Opposite, Completion, and Verbal Analogies. The Quantitative Test is concerned with Arithmetical Reasoning, Number Series, and Tables. This test is altered from year to year, the alterations depending upon apparent weaknesses that appear or from changes that develop in student make-up. Details regarding this test may be found in the May, 1940, issue of the

[1] *Psychological Examination For College Freshmen*, The American Council on Education, Washington, D. C., 1939.

Educational Record, the publication of the American Council on Education.

In order to determine the physical skill of these students, the Johnson Physical Skill Test for Sectioning Classes into Homogeneous Units was administered. This test consists of a series of ten exercises performed upon a chart 15 feet in length, which is placed upon a gymnasium mat. The elements of strength, speed, and endurance are unnecessary for the successful passing of this test, skill alone being the factor considered.[2]

The scores that were earned in the Psychological Test were then compared with the scores that the students made in the Physical Skill Test.

Then a comparison was made between the scores of the Psychological Test and the grades these students received after their first quarter of general University work. Another comparison was made between the scores of the Johnson Test and the academic grades.

The results of these studies suggested an examination of the relationship that existed between the skill scores of the Johnson Test and the grades that these students earned in the Department of Physical Education.

An observation was made of the sex differences, particularly as these related to the Johnson Test.

It should be said at this time that most academic grades are of necessity characteristically subjective. This statement is likewise true with reference to the grades earned in physical education activities. However, the grades for both men and women in physical education were made by two or more individual scorers for each student. This program for the men included a measure of sorts of the skills involved in mat tumbling, wrestling, and basketball; while the same thing applied to the program for the women, which included the modern dance and varied individual and team sports.

THE RESULTS

The results of these studies showed:

The coefficient of correlation between the Psychological Test and the Johnson Skill Test was –.059, with a standard error of correlation of .093.

The coefficient of correlation between the Psychological Test and the earned academic grades was .476 with a standard error of correlation of .073; this is slightly significant.

The coefficient of correlation between the Johnson Test and earned grades in the general academic fields was .068 for the men with a standard error of correlation of .07, and a coefficient of

[2] Granville B. Johnson, "Physical Skill Tests for Sectioning Classes in Homogeneous Units," *Res. Quart.*, 3:1 (March 1932) 128.

correlation of .075 for the women with a standard error of correlation of .075.

The coefficient of correlation between the Johnson Test and skill grades in physical education activities was .1985 with a standard error of correlation of .087.

CONCLUSIONS

The results of this study would seem to indicate that:

1. There is no significant relationship between physical skill as measured, and mental power or general intelligence as measured.
2. There is just a meager relationship between intelligence as measured and academic grades.
3. There is no significant relationship between physical skill and academic grades.
4. There is but a hint of a relationship between skill and grades in physical education activities.
5. There is no sex difference in either physical skill or academic achievement.

The question immediately suggests itself: if the integrated personality can be measured, what are the fundamental difficulties with our present measuring technique, or does the trouble lie deeper in the surge of the cross-currents of human behavior? Does the complete personality contain elements that can not be measured, yet can easily nullify rational prognostication?

Included in this experimental group were 36 students who were members of the volunteer leader corps; they joined the corps of their own free will and accord. These young men were characterized by their relatively high scores in both the American Council and the Johnson Tests; moreover, their academic grades were all in the upper 80 percentiles. The achievements of these particular students seem to indicate that teaching and learning as a living process must be a cooperative enterprise—with increased emphasis upon proper motivation, the establishing of readiness, or by stimulating interest —this on the part of the teachers. At the same time, the learner must somehow be brought to realize that the complete personality is at least a three dimensional organism with certain mental, physical, and emotional capacities that depend for development upon a cooperative, industrious, and aggressive attitude that wills, or has for its main purpose, achievement.

Principles and Procedures in the Conduct of "Interscholastic" Athletics for Adolescent Girls

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THE problems of interscholastic athletics for girls have been for many years before leaders in the fields of health, of physical education, and of recreation. Certain national organizations have established standards,[1] platforms,[2] and policies[3] governing athletics for girls.

This present study was made for the purpose of determining those principles and procedures in the conduct of competitive athletics for adolescent girls which are approved by national organizations conducting such programs.

Eleven national groups cooperated in this study: Amateur Athletic Union (U)[4]; National Amateur Athletic Federation, Woman's Division (F); National Society of State Directors of Physical Education and Health (S); National Society of Directors of Physical Education for College Women (D); National Section on Women's Athletics of the American Association for Health, Physical Education, and Recreation (W); National Council of Catholic Women (C); National Federation of State High School Athletic Associations (A); Young Women's Hebrew Association (H); Young Women's Christian Association (Y); National Recreation Association—civic groups (R), and industrial groups (r).

Each of these national organizations recommended individuals qualified both by experience and by professional position to serve on the jury to determine principles governing girls' athletics. These members were also approved for jury membership by two other officers of their national organization (the two recent past presidents, except where such were not available). The thirty-three members of this jury were in eighteen different states and the District of Columbia, representing all sections of the country from Connecticut and New York in the east to California and Utah in the west; from Minnesota and Michigan in the north to Alabama and Texas in the south.

From a study of the literature of the past ten years, problem

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This paper is a digest of a doctoral thesis.
1 National Section on Women's Athletics.
2 Woman's Division of National Amateur Athletic Federation.
3 National Federation of State High School Athletic Associations.
4 The identifying symbol by which these organizations will be known in this study.

areas were determined and then educational principles were constructed to be presented to this jury for criticism—to be approved, disapproved, revised, and commented upon by each member. These proposed principles covered each of the following problem areas:

Objectives of competitive athletics for adolescent girls.

Types of competition.

Organization and administration of competitive programs—preliminary planning, location of the place for the program, selection of the activities, student participation in planning and in administering the program, equalizing competition, eligibility of players and their classification, size, type, and affiliation of competing organization, the physical plant, equipment, facilities, and materials, uniforms, officials, schedules, safety measures, transportation of players, rules for games, scorekeeping and recognition of winners, finances.

Committees, leadership, and sportsmanship.

Public relations and publicity.

Post-program responsibilities.

Before sufficient agreement could be reached by members of the jury to establish principles or policies, three separate lists of principles and policies were submitted. Whenever 26 members agreed upon a principle, it was established (since, according to the standard error of a proportion and the standard error of a difference between two proportions, if the jury were increased to 100, the chances are 14 in 10,000 cases that more than half of the members would be in agreement).

Whenever 25 or 24 agreed, the principle or policy was recommended as important for consideration but not as established since the chances are more than 25 and 183, respectively, in 10,000 cases, that more than half would agree if the jury were increased to 100.

When principles and policies had been established or recommended for every problem area governing competitive athletics for adolescent girls, an investigation was made of current practice in this field. Each of the national organizations had state or regional representatives, 362 of whom recommended a total of 639 individuals who in their localities were demonstrating the best practice in the conduct of competitive athletics for girls. Of these "best practice" individuals, only 73 received the recommendation from more than one organization's representative, and only 30 of these were found to be qualified for further investigation. They were located in twenty-three states from Washington to Georgia and from Massachusetts to Oklahoma, thus representing all parts of the country. By means of conferences, reports, and questionnaires, their procedures in the conduct of competitive athletics for adolescent girls were discovered and compared with the jury's principles and policies. Only those procedures found to be in accord with these principles were accepted as desirable.

The principles and policies are given under the problem areas with which they are directly concerned.

PRINCIPLES AND POLICIES ESTABLISHED BY THE NATIONAL JURY

Objectives.—The chief value in any program of competitive athletics lies in its contribution to the welfare of the participants.

Properly conducted "interscholastic" athletics for girls tend to develop in the participants improved neuromuscular skills.

Athletic competition that places emphasis on the playing rather than upon the winning of the game brings greater benefit and satisfaction to all.

Types of Competition.—Citizenship in a democracy requires that youthful loyalties to small groups be broadened to include larger numbers. For youth in a democracy, the spirit of cooperation is of value.

The nature of the activity and the attitudes associated with competition in the events influence the outcomes from tournament play. For example, in most situations, less emotional strain exists in shuffleboard than in baseball tournaments. Girls' basketball tournaments—national, state, and district—involve physical and emotional strains undesirable for adolescent girls.

The following types of competition are *approved* for adolescent girls:

Intramural competition in archery, badminton, basketball (N.S.W.A. rules), bowling, field hockey, games such as horseshoes and croquet, golf, quiet games, shuffleboard, softball, swimming, table tennis, tennis, and volleyball;

Playdays involving competition in archery, badminton, basketball (N.S.W.A. rules), bowling, games such as horseshoes and croquet, golf, quiet games, shuffleboard, softball, swimming, table tennis, tennis, and volleyball;

Sports days involving competition but no tournaments in archery, badminton, games such as croquet and horseshoes, golf, quiet games, shuffleboard, softball, swimming, table tennis, tennis, and volleyball.

The following types of competition are *disapproved* for adolescent girls:

District or county tournaments in track and field events;

State tournaments in basketball, bowling, field hockey, golf, soccer, softball, swimming, track and field events, and volleyball;

National tournaments in dual and in individual games—badminton, bowling, golf, swimming, tennis, track and field events, also in team games—basketball, field hockey, soccer, softball, and volleyball.

Competitive athletics for adolescent girls should not be state-wide nor national in scope.

The following events are not desirable for athletic competition for adolescent girls: basketball (boys' rules), football (girls' rules), runs (100 yards or more), hurdles (3½ feet in height and 75 yards or more in distance run).

Organization and Administration of the Program.—The success

of a program in competitive athletics depends upon adequate preliminary preparation and efficient organization for smooth functioning.

Selection of Activities.—Provision should be made for all to participate in activities suited to their interests and abilities.

Because of the adolescent's physiological stage of development, activities requiring skill are beneficial, while those demanding endurance, strength, or a high degree of speed are undesirable.

Coeducational athletics are of value to adolescents when the activities do not involve personal contacts, do not give special advantage to either sex, and are suited to the interests and abilities of those participating.

Student participation in planning the program is important. The objectives in a program are more readily obtained when they are desired by all participating groups. Girls tend to enjoy those activities in the choice of which they have been consulted.

Equalizing Competition.—Equalization of competition (i.e., teams made similar in skill) is desirable since it brings to the participants more personal enjoyment, physical safety, and social satisfaction.

Eligibility and Classification of Players.—Desirable eligibility requirements for girls in athletics are: a health certificate from a reputable physician, parents' consent for participation, and bona fide membership in the organization represented by the team.

When matched for athletic competition it is desirable that adolescent girls be somewhat alike in skill.

Homogeneous groups (i.e., similar in age, size, and type of personnel) for competition are best organized among players from institutions that are the same in size and type.

The Physical Plant, Equipment, and Facilities.—In order that all may benefit through participation in athletic contests, the number of players invited will be determined by the facilities available for the types of games played.

Participation of all rather than of the few is desirable, hence playing space, facilities, equipment, and materials should be provided adequate for any climate or weather conditions.

Adequate provision for personal comforts and conveniences (such as lockers, showers, and dressing rooms) bring satisfaction to all participants in any athletic event.

When selecting uniforms for girls in athletics, the following considerations are essential: the comfort and becomingness of the garment, the appropriateness for the specific activity, the cost and availability for use.

Officials.—A woman official for girls' athletic contests is better than a man except where personality traits and expertness in officiating are markedly inferior.

The success of a program in competitive athletics depends upon

the selection of non-partisan officials and the expertness of all officials.

Schedules.—Competitive athletic events for adolescent girls should be scheduled in the mid-morning or afternoon rather than near meal times or at night.

The adolescent girl should be at home when night comes; hence, athletic contests scheduling out-of-town teams must be at an hour that allows time for these teams to reach home before night.

Adolescent girls participating in athletic programs need to return home before midnight.

Causes of fatigue in athletic competition for adolescent girls will be lessened when not more than one competition in a strenuous game is scheduled in the same week; not more than one is scheduled in the same day; vigorous activities do not immediately precede or follow a meal, or another vigorous activity; the duration of vigorous activity is limited by the player's needs and physical condition; activities are suited to the climate; and no undue emotional stimulation exists.

Safety Measures.—Since an excess of physical and emotional fatigue brings negative results to players, all factors causing overfatigue to players should be avoided when planning athletic contests.

A knowledge of the health of each participant is essential to prevent the spread of certain diseases, to safeguard against a player's illness during the program, and to lessen chances of physical injury in the activities.

Safety and health require that all facilities, equipment, and materials used be in good condition and that first aid and medical attention be readily available when needed.

Transportation of Players.—The transportation of all athletic teams of adolescent girls should be under the control of the organization represented by the team.

Rules for Playing the Game.—Those rules for athletic contests are best that are constructed by an authorized group who are interested primarily in the welfare of the player rather than in the game per se or in the spectators.

The rules published by the National Section on Women's Athletics of the American Association for Health, Physical Education, and Recreation are best for girls' athletic competitions.

Scorekeeping and Recognition of Winners.—The best scoring system is one that contributes to the objectives for which the program is planned.

It is desirable to give recognition to the team or group rather than to the individual as this tends to motivate the development of team spirit rather than of self-interest.

Accuracy, clarity, and fairness are essential features in scoring.

A reward for athletic achievement is desirable only as it contributes to attaining the educational objectives of the game and is not an objective per se.

Finances.—That method of financing an athletic program is best that adequately meets essential needs without handicapping the attainment of the educational objectives in the program.

Since gate receipts involve the necessity of having winning teams to draw large audiences, and this in turn produces conditions that are antagonistic to the best objectives of the program, gate receipts are not the best means of financing the program.

It is essential that organizations sponsoring the athletic program contribute the needed funds from their own budgets whether raised by fees or assessments, since these funds are definite and in securing them the conduct of the athletic program is not affected.

The desire to make money should never become an objective of any athletic program.

Only competent, honest individuals should be intrusted with the handling of finances for athletic programs.

Committees, Leadership, Sportsmanship.—The best results are obtained in the organization of any program when committee members are always chosen for their interest and qualifications to do the work assigned; committee members are not overloaded with duties; written instructions are given to committees; and reports of work accomplished are required from all committees before the time set for the program.

Better cooperation from all results when there is more complete understanding of the work to be accomplished.

The attitude and behavior of adult leaders and spectators readily influence feelings and actions of adolescent girls.

The success of a program of competitive athletics depends upon adequate training of coaches.

It is desirable that a chaperone accompany the adolescent girl when away from home.

The success of a program of competitive athletics depends upon a spirit of friendliness among participants, and desirable personality traits of all leaders.

Definite planning is needed for insuring good sportsmanship and desired social and personality development through athletic contests.

Public Relations and Publicity.—The public's attitude toward any athletic program is influenced by the information it receives concerning this program.

National, state, and local sources may be drawn upon to improve programs of athletics for girls; for example, officials that are "rated" by national agencies, standards which are established, printed aids

for organizing and conducting contests, all are available in many localities.

Post-Program Responsibilities.—Wherever funds are handled, proper auditing protects the treasurer and the organization.

Economy demands that all materials and equipment, after being used, be put away in good condition for future use.

Records of past successes and failures are an aid to future planning for any athletic program and should be filed so as to be available for the use of both local and state organizations.

The good will and cooperation of all is retained when courteous expressions of appreciation are given for services rendered in the conduct of the athletic program.

PRINCIPLES AND POLICIES RECOMMENDED FOR DUE CONSIDERATION

Objectives.—Properly conducted "interscholastic" athletics for adolescent girls tend to develop in the participants increased physical fitness, broadened social development, and sportsmanship.

Types of Competition.—Telegraphic meets are approved in those activities in which varying conditions of play can be standardized, as in swimming and in archery.

Types of athletic competition disapproved for adolescent girls are: state-wide inter-group contests in team games.

The following types of competition are *approved* for adolescent girls:

Intramural competition in soccer.
Playdays including competition in field hockey.
Sports days with competition but no tournaments in basketball (N.S.W.A. rules).

The following types of competition are disapproved for adolescent girls:

District and county tournaments in basketball, field hockey, and soccer.
State tournaments in archery, badminton, games such as horseshoes and croquet, quiet games, shuffleboard, table tennis, tennis.
National tournaments in archery, games such as horseshoes and croquet, quiet games, shuffleboard, table tennis.

In this connection, a policy to be considered is that the location should not require more than two hours of travel for any team.

Uniforms.—When selecting uniforms for girls in athletics the uniform's effectiveness for team differentiation is an essential consideration.

Safety Measures.—The organizations sponsoring an athletic program are responsible for the safety of all participants.

CONCLUSIONS CONCERNING PRINCIPLES

National leaders in athletics for adolescent girls, as represented by members of the jury composed of qualified persons, are in agree-

ment concerning the general conduct of athletic programs except where the type of competition is concerned. Here, these leaders agree in approving intramurals, playdays, and sports days, and in disapproving state and national tournaments but they are divided on the question of county and district tournaments, and on the advisability of track and field events in intramural, playdays, and sports days.

Within the organizations cooperating there is also sometimes lack of uniformity of opinions. This is most frequently the case in the following organizations: U, W, and H, with r, C, and A disagreeing to a lesser degree and F, Y, D, R, and S agreeing most frequently concerning types of competition to be approved for girls.

It is recommended that further study be made to determine the advisability of competitive athletics for adolescent girls in district and county tournaments.

CONCLUSIONS CONCERNING BEST PRACTICE

Leaders in national organizations that deal with adolescent girls in competitive athletics do not agree upon which individuals in their state are demonstrating best practice in this field. Many[5] disapprove all interscholastic athletics and would limit competition to intramural and to playday programs.

A comparison of best practice with established principles leads to the conclusion that athletic competition in sports days *where no tournaments are played,* and a few friendly games with neighboring cities, are approved for adolescent girls but that "interscholastic" tournaments are condemned.

In the general conduct of athletic programs, individuals representing the best practice agree. Differences in practice occur only in a few areas of minor importance to the welfare of participants.

Emphasis in all competition is upon the social factors rather than upon winning games. Championships and athletic records, activities of excessive endurance, strength, or speed, travel of distance exceeding two hours, gate receipts, publicity featuring individuals, undue emotional stimulation of players, or any practice not resulting in the welfare of participants are banned.

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[5] Eighteen of the 48 "best practice" individuals recommended by more than one representative were found to conduct only intramural or playday competition for adolescent girls. Fifteen representatives disapproved of interscholastic competition.

Ophthalmic Scoliosis

A Consideration of a Probable Causation in Scoliotic Conditions of Children

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Texas State Board of Health, Austin, Texas

OPHTHALMIC, or glare-induced scoliosis, as differentiated from empyematic, habitual, inflammatory, myopathic, osteopathic, or paralytic scoliosis is, for the purpose of this paper, a curvature of the spine attributed to the excessive light stimulation striking the peripheral retina of the eye producing an interference with the working materials focused on the fovea. This condition has, as a major concomitant, the irregular lighting of the classroom. It is not to be thought that this maladaptation of the organism to an environment is something entirely new or relevant to a particular geographical location, for it can be observed in any classroom, regardless of where it may be.

In order that one may visualize the condition which is the topic of this paper, it is necessary to recall the appearance of a group of pupils, say, in the fourth grade, writing a composition. The children are bent in various directions over their papers, some leaning on elbows, others with their heads askew from the horizontal seating position. Again, the spine may assume an S shape while the head completes an angle of incidence counter to the position of the atlas. It is true that inadequate seating facilities contribute greatly to the scoliosis but that is out of the range of the present investigation. It appears possible that illumination (for instance, glare spots in the field of vision) is a forcefully contributing factor to a condition of visual fatigue and as a direct resultant, ophthalmic scoliosis.[1]

The room in which these measurements were made had six rows across and nine seats in each row, 54 children in all. This schoolroom area was broken up to include Section 1, rows six and five with seats one and three, inclusive for both. Section 2 included the two rows and the same number of seats on the opposite side of the room. Section 3 included rows four and three with seats four, five, and six, inclusive for both of the rows. (See Figure I.)

Section 4 was for rows six and five with seats seven to nine, inclusive for both rows in the corresponding section at the opposite

A paper read before the Psychological Section of the American Association for the Advancement of Science, Dallas, January 1942.

1 C. F. Ferree, and G. Rand, *"Lighting in its Relation to the Eye,"* Proc. *Am. Philosophical Soc.*, 57 (1918) 440-478.

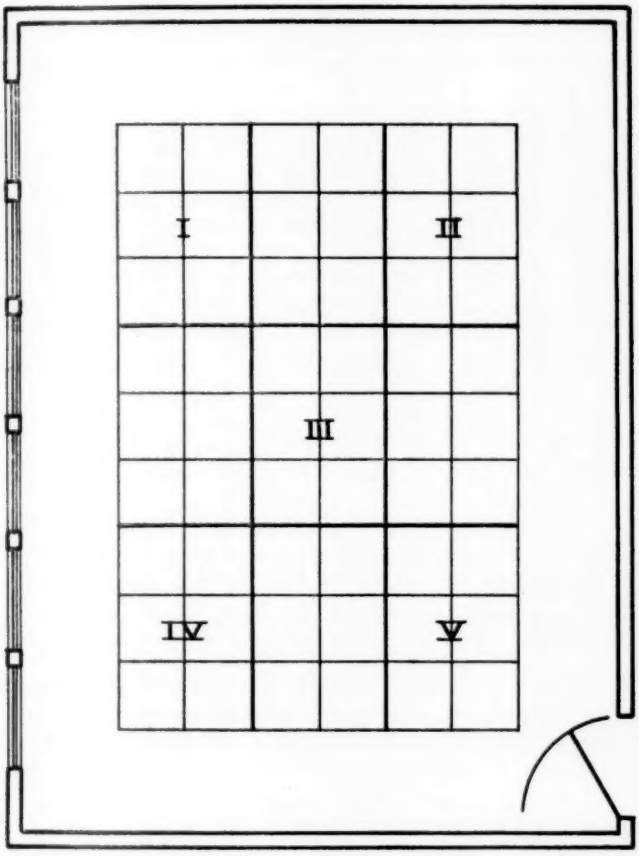

FIGURE I

side of the room. Row six, as will be noted from the chart, was next to the windows of the room, while row one was the unilluminated area in this room. This fact should be kept in view in consideration of data of the head and body rotations shown in Tables I to VI.

Table VI shows the degree of rotations, both lateral and ventral-dorsal of the children in the various sections of the room with the corresponding areas of illumination. The head angles were calculated with the use of a perimeter placed on a plane which would transect the pelvic region when the subject was in a relaxed position. An extension of the plane enabled the experimenter to read off the lateral rotations as right or left by so many degrees. In the same manner the trunk angles were calculated with the use of a perimeter placed on a plane which would transect the axis of the iliac bones. An extension of the plane enabled the experimenter to read off the ventral-

TABLE I
SECTION 1

Case	Row	Seat	Surface Plane f. c.	Reading Plane f. c.	Eye Plane f. c.	Head Plane Direction	Reading Plane Angle	Reading Dist. Pref.	Off Center	Head* Angle	Trunk Angle	Head† Angle	Trunk Angle
1	6	1	100	75	135	L	50°	12″	R 5″	L 25°	R 25°	30°	50°
2	6	2	100	80	132	L	45°	4″	L 6″	L 42°	L 35°	30°	40°
3	6	3	100	78	130	L	48°	6″	L 4″	L 45°	L 28°	35°	35°
4	5	1	50	42	125	L	40°	10″	0	L 35°	L 30°	30°	35°
5	5	2	56	45	125	L	43°	7″	R 2″	L 32°	L 25°	32°	31°
6	5	3	58	44	120	L	42°	6″	R 5″	L 30°	L 29°	28°	25°
Total									R12″		R 25°		
			464	364	767		268°	45″	L10″	L210°	L147°	185°	216°
									0				
									22″		29°		
Average									R4″		R25°		
			77	61	128		45°	8″	L5″	L35°	L30°	31°	36°
									0				
									4″		29°		

Note: Throughout the six tables, all decimals have been changed to round figures. R means right; L, left.

*** Lateral rotation, R-L, through pelvic region—same in all tables.**

† Ventral-dorsal rotation through axis of iliac bones—same in all tables.

dorsal rotations by so many degrees. The right or left rotations may be partially answered by the right or left handedness of the individual. On the other hand the environmental restrictions, i.e., illumination,

TABLE II
SECTION 2

Case	Row	Seat	Surface Plane f. c.	Reading Plane f. c.	Eye Plane f. c.	Head Plane Direction	Reading Plane Angle	Reading Dist. Pref.	Off Center	Head Angle	Trunk Angle	Head Angle	Trunk Angle
1A	2	1	20	14	50	L	80°	16″	L4½″	L30°	L20°	30°	0
2A	2	2	20	14	42	R	40°	8½″	R5″	R25°	L30° R25°	25°	0
3A	2	3	25	20	67	R	Parallel	10″	R6½″	R35°	0	50°	30°
4A	1	1	10	10	30	L	Parallel	8″	L 7″	L62°	R25°	0	Dorsal 20°
5A	1	2	8	9	30	R	10°	10″	R 4″	R 5°	R 8°	0	10°
6A	1	3	12	10	30	R	20°	12″	L 3″	R15°	L10°	5°	0
Total									L15″	R80°	L60°		
			95	77	249		150°	65″	R16″	L20°	R58°	110°	60°
									30″	100°	90°		
Average									L 2″	R20°	L20°		
			16	13	42		25°	11″	R 3″	L20°	R20°	19°	10°
									5″	17°	15°		

TABLE III
SECTION 3

Case	Row	Seat	Surface Plane f. c.	Reading Plane f. c.	Eye Plane f. c.	Head Plane Direction	Reading Plane Angle	Reading Dist. Pref.	Off Center	Head Angle	Trunk Angle	Head Angle	Trunk Angle
1B	4	4	24	20	90	L	Parallel	12″	L6½″	L35°	0	40°	30°
2B	4	5	35	30	100	L	45°	5″	L 5″	L30°	R30°	35°	26°
3B	4	6	40	35	100	L	40°	5″	L 4″	L28°	L25°	30°	29°
4B	3	4	24	18	75	L	30°	4″	L 5″	L25°	R20°	20°	25°
5B	3	5	27	20	60	L	31°	4½″	R 3″	L22°	R25°	22°	21°
6B	3	6	16	12	60	R	60°	18″	R 4″	R30°	L40°	10°	15°
Total									R 7″	170°	R75°		
			166	135	485		206°	49″	L21″	R30°	L65°	157°	145°
									28″		140°		
Average									R4″	28°	L38°		
			28	23	81		34°	6″	L5″	R30°	L33°	27°	24°
									5″	L28°	23°		

glare spots in the foveal field of vision, seating inadequacies, etc., would tend to induce rotations of a more severe order, in the direction determined by the restricting force. It is important that from Section 1 to Section 2 in Table VI the lateral rotation of the head angle is from 35° to 17°, and in the ventral-dorsal rotation of the head angle the difference is from 31° to 18°.

One may tentatively conclude from this significant difference that the amount of rotation is directly proportional to the illumination.

TABLE IV
SECTION 4

Case	Row	Seat	Surface Plane f. c.	Reading Plane f. c.	Eye Plane f. c.	Head Plane Direction	Reading Plane Angle	Reading Dist. Pref.	Off Center	Head Angle	Trunk Angle	Head Angle	Trunk Angle
1C	6	7	100	80	115	L	45°	3″	L4″	L28°	R25°	40°	40°
2C	6	8	130	88	150	L	52°	7″	L4″	L30°	L35°	40°	27°
3C	6	9	100	75	195	L	47°	0	L7″	L25°	L20°	45°	30°
4C	5	7	58	40	88	L	70°	6″	0	L20°	L27°	42°	35°
5C	5	8	50	30	110	L	Parallel	7″	R3½″	125°	R40°	40°	Dorsal 25°
6C	5	9	40	25	90	L	45°	5″	R4″	L28°	R20°	38°	29°
Total									L15″		R85°		
			478	338	748		259°	36″	R8″	L156°	L82°	245°	196°
									23″		28°		
Average									L5″		L27°		
			80	56	125		43°	6″	R4″	L26°	R28°	41°	33°
									4″		28°		

TABLE V
SECTION 5

Case	Row	Seat	Surface Plane f. c.	Reading Plane f. c.	Eye Plane f. c.	Head Plane Direction	Reading Plane Angle	Reading Dist. Pref.	Off Center	Head Angle	Trunk Angle	Head Angle	Trunk Angle
1D	2	7	15	8	55	R	Parallel	14″	L1″	R25°	L10°	25°	0°
2D	2	8	13	5	55	R	30°	8″	R6″	R20°	0	20°	15°
3D	2	9	12	6	50	L	5°	10″	R4″	0	R5°	30°	20°
4D	1	7	12	5	50	R	25°	12″	L2½″	0	0	45°	0
5D	1	8	11	4	50	R	26°	6″	L2″	R30°	0	40°	30°
6D	1	9	10	4	15	L	8°	5″	L2½″	L20°	L25°	40°	Lordosis 20°
Total			75	33	205		94°	55″	L8″ R10″	L20° R25°	L60° R5°	200°	9°
									18″	95°	65°		
Average			12	6	59		16°	11″	L2″ R3″	L20° R25°	L20° R5°	33°	14°
									5″	13°	11°		

The rotation from Section 4 to Section 5 has on an average the same amount of distortion as was explained for Section 1 to Section 2. The head angle of the lateral rotation in Section 4 is 26°, while that of Section 5 is 13°. The head angle of the ventral-dorsal rotation in Section 4 is 41°, while the corresponding area in Section 5 is 33°.

The data in the tables cover 54 pupils in the lower fourth grade at Corpus Christi, Texas.

DISCUSSION

Neurologically, a curve of the spine as a resultant of visual stimulation may be explained partly by the neurobiotactic hypothesis of dendrite extension which, as Kapper states, is that "dendrites grow toward an active neuron or nerve bundle, providing that the neuron from which the dendrite grows and the neuron toward which it grows are in excitation simultaneously or in close succession,"[2] and, perhaps,

TABLE VI
COMPOSITE DATA OF AVERAGES FOUND IN TABLES I TO V

	Surface Plane f. c.	Reading Plane f. c.	Eye Plane f. c.	Reading Plane Angle	Reading Dist. Pref.	Off Center	Head Angle	Trunk Angle	Head Angle	Angle Trunk
Section 1	77	61	128	45°	8″	4″	35°	29°	31°	36°
Section 2	16	13	42	25°	11″	5″	17°	15°	18°	10°
Section 3	28	23	81	34°	6″	5″	L28°	23°	27°	24°
Section 4	80	56	125	43°	6″	4″	L26°	28°	41°	33°
Section 5	12	6	59	16°	11″	5″	13°	11°	33°	14°

2 C. U. A., Kappers, described in Child (1921), Holt, (1932), and Freeman (1934).

completed with the inclusion of the hypothesis of stimulogenous fibrillation (S.T. Bok), which attempts to account for axone growth from a point of stimulation.

On the other hand, one might raise the question: Is this a problem to be explained by neurophysiology? Could not the asymetrical body patterns be explained as a matter of activity on the musculature unilaterally supporting the head? We do know that activity promotes growth and thus in this instance of unilateral stress, one muscle hypertrophies, producing a constant excess traction pulling on the spinal supporting ligaments in one direction which results in a spinal curvature. For example, a child exposed to excessive peripheral retinal stimulation may first rotate the body to overcome the points of glare striking his eye from such extraneous sources as reflective materials in the classroom or sky illumination from uncontrolled origins. The rotation of the body, coupled with the fatigue elements of supporting the head (the visual plane) in a vertical position to the spine which is, under these conditions, off center, allows for unilateral relaxation of the longissimus capitis, sternomastoid, sternocleidomastoid, and trapezius muscles which extend, abduct, and rotate the skull. In turn, the head approaches the plane of the working materials as fatigue becomes more and more severe. Instead of the child maintaining a refraction which should be emmetropic, the axis of the eye is lengthened (the rays being focused in front of the retina) and myopic vision is the result. One may argue that this is functional myopia and not true myopia. That is true, but should this condition of simulated myopia continue over a long period of time, functional disability may become an organic lesion.

It is not to be interpreted that the condition which has been defined as ophthalmic scoliosis is definitely proved, for this paper is an attempt to present materials which might contribute to a scoliotic condition in children. The validity of the research rests upon continued investigation, which the author is now undertaking.

SUMMARY

These results must not be interpreted as being conclusive or indicative of an invariable condition, but it is the opinion of the author, who has had an opportunity to investigate a large sampling of Texas children from the primary to the secondary level, that this scoliotic condition increases in severity with the maturation of the individual.

Results obtained from one grade studied intensively, namely, the fourth grade, might indicate that the lateral and ventral-dorsal rotations decrease with the decrease of brightness areas in the line of the visual plane.

The evidence presented indicates not only the prevalence but the severity of ophthalmic scoliosis. Its correction, if correction is to

be secured before the scoliotic condition becomes an organismic reality by induction of dysfunctional stresses, may be found in equalized illumination of classrooms, particular attention being given to such conditions in the lower grades.

A Study of Health Education in Schools of the Central District

By Bessie F. Keeney

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MANY persons in and out of the field of education are recognizing the importance of health education and health service in present-day educational institutions. Among the pertinent questions in this field are: Under what conditions is health actually being taught? Is health service being offered in our present-day public schools? What is included as health service?

PROCEDURE

In cooperation with the Central District Physical Education Association, a survey of certain aspects of health education was made by sending questionnaires to the nine states of the district. Two states, Wyoming and North Dakota, made no reply. A questionnaire (Form *A*) was sent to 509 elementary, secondary schools, and colleges in the remaining seven states of the Central District. Returns were received from 36.4 per cent of these schools. A more detailed questionnaire (Form *B*) was sent to all schools in cities of 5,000 population or more in three states, and to all colleges on the accredited list in these states, a total of 105. Returns were received from 240 questionnaires, a total of 42.7 per cent.

For evaluation, two authoritative reports on health standards were used. The first is a committee report, "Suggested School Health Policies," accepted by many professional groups interested in health, which was published in the *Journal of Health and Physical Education*, May and June, 1940. The second is a pamphlet, "The Organization and Administration of School Health Work," by John W. Studebaker, United States Commissioner of Education, and the late Dr. Fred Moore, Director, Department of Health, Public Schools, Des Moines, Iowa.

The findings from the survey are discussed in light of the recommendations made in these two publications.

RESULTS

Findings from questionnaire *A* (Colorado, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota) were as follows:

1. Courses of study in health education are used in approximately two-thirds of the schools at the elementary level, one-half at

the junior high level, and one-fourth at the high school and college levels. The authorities consider the use of a planned, graded program essential to successful health teaching.

2. The classroom teacher is the chief person responsible for health education in the elementary schools; the instructors of physical education, science, and home economics share the responsibility with the homeroom teachers and the physicians and nurses at all other levels.

The authorities recommend that the elementary teacher should give health instruction, and pay particular attention to developing proper attitudes and habits of conduct in the elementary grades. At the other levels the responsibility may vary depending upon individual school organization.

3. Nine-tenths of the elementary schools give health information through textbooks and reference readings. Reading, lectures, and discussion predominate as teaching methods at all other levels. Modern methods such as field trips, projects, and contacts are rarely used in the elementary schools, and slightly more often in high schools and colleges.

The authorities recommend that textbooks and references be kept up-to-date and scientifically correct; that teachers keep constantly in touch with publishers and equipment companies; that visual aids, projects, field trips, and results of health and dental examinations be used to supplement reading material.

The more detailed findings (Form *B*) from Iowa, Missouri, and Kansas showed:

1. Health teaching is integrated in the curriculum with the biological and physical sciences, social sciences, and language and fine arts. Responsibility for integration falls upon the physical education departments in a large percentage of the cases.

According to the authorities, integration through the cooperation and united planning of all departments is essential in any health program.

2. Three-fifths of the schools at the elementary and secondary levels include communicable disease control and medical treatment, chiefly first aid, as part of health service; half of the schools include physical and medical examinations. Three-fourths of the colleges offer medical treatment and one-half of them give medical and physical examinations.

The authorities recommend that health service should include physical examinations and follow-up attention for every student, measures for control of communicable disease, control of the school environment—physical, academic, and social—and first aid. Major forms of medical treatment are not a school function. They are a part of the parents' responsibility.

3. Health records are kept in a large percentage of the cases. The classroom teachers and nurses are primarily responsible. Recommended procedure is to have the nurses keep health records and to interpret them carefully to each student and his teachers.

4. Aims of the administrators at the elementary and secondary levels are to provide opportunity for building desirable attitudes toward health, to practice health habits, and to promote general improvement in personal health. Statements by college administrators express their aims as building desirable attitudes concerning personal health, striving to build a desire for general health improvement, providing for health knowledge, and providing opportunity to develop and practice good health habits.

The aims expressed by the authorities are in the forms of definite administrative objectives, including provision of a healthful environment, first aid, cooperation for preventing and controlling communicable disease, a graded program of health instruction and experiences, periodic health examinations, follow-up activities, special programs for handicapped pupils, and in-service training for teachers.

5. The main problems recognized by administrators relate to securing adequate facilities and time for conducting the health program.

The authorities consider that the basic problem is the formulation and statement of principles and adequate planning for administration.

6. Those who have a specific health program state that health education should be provided for as a regular part of the academic program, planned and directed by the nurse and physician or a teacher prepared in health education, and financed in elementary and secondary schools by the board of education. At the college level they state that the program should be financed by student fees assessed for that particular purpose.

The authorities believe that as an educational program school health activities are most efficiently administered as part of the regular academic curriculum and financed by the department of education.

7. In practice no uniformity or central tendency was discovered in the time allotments given to health teaching and health service.

The Committee Report suggests that direct health instruction be offered five periods per week for one semester at both the junior and senior high school levels. Credit, comparable to that for other academic subjects, should be given for instruction in this field.

CONCLUSIONS

While the study reported here is by no means a complete picture of the health program in the schools of the Central District, it prob-

ably represents current practice above, rather than below, the average. It is, therefore, a conservative statement to say that the health program in the schools of this region needs a great deal of constructive development. The following steps seem to be most important:

1. The school administrator should formulate a philosophy of health education including general aims and more specific objectives. He should carry out this philosophy through a careful long-time plan applicable to his situation.
2. Courses of study in health should be more generally used at all levels.
3. Training for health teaching including modern methods, should be given to all classroom teachers and to specialized teachers of physical education, home economics, general science, nurses, and medical students interested in public health education.
4. Health examinations should be given more universally and more frequently.
5. The health program should be accepted as an important part of the school program, financed through regular school funds.
6. Because of the national emergency, the above facts should be brought to the immediate attention of the state departments of education in the Central District.

Pulse-Rate Reaction of Children to Graded Exercise

By Genevieve L. Braun
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HEART-RATE tests have been developed and standardized largely on people of college age. Little has been done to set the limits of normality of resting and exercise heart rates in younger children, since it is generally considered that the pulse in this age group is too variable. However, teachers of elementary pupils occasionally have need of the knowledge of the normal pulse rate in children under circumstances such as are found in the public schools. With these thoughts in mind, this study was undertaken.

PROCEDURE

All subjects were healthy, normal children between the ages of nine and twelve. The school medical history of each child was consulted to note the incidence of any past illness. On the day of the experiment, the child reported to the nurse's room of the school instead of attending his regular physical education class. After a short practice of the test exercise, the subject rested in the recumbent position until the radial pulse became stabilized (three successive readings being identical). The subject then stood quietly and the heart rate was again counted in 15-second intervals until stabilization occurred.

The exercise was like that used in the Tuttle pulse-ratio test (Tuttle, 1931) except for the rate of performance and the height of the stool. The stool height was changed from 13 to 12 inches to accommodate the shorter legs of the children. For the slow exercise the metronome was set at 60, making a total of 15 trips on and off the stool per minute. For the fast exercise, the metronome was set at 88, making 22 trips per minute. In each case the exercise lasted one minute. Upon completing the slow exercise, the subject immediately reassumed the recumbent position and the pulse rate was again recorded in 15-second intervals for two minutes. In most cases, this time was sufficient for the heart to return to the pre-exercise level. The procedure was then repeated for the fast exercise. The recumbent instead of the sitting position was chosen for the post-exercise pulse count to eliminate heart rate changes due to the hydrostatic effect of gravity. No attempt was made to determine pulse ratios.

RESULTS AND DISCUSSION

Crampton (1920) judges the ability of the circulatory system to counteract the hydrostatic effect of gravity by the change in pulse rate and systolic blood pressure occurring when the individual moves from a recumbent to a standing position. A good response is indicated by a small acceleration in heart rate and by the ability to maintain the arterial blood pressure at its horizontal level. Figure I and Table I show that the difference between the average recumbent and

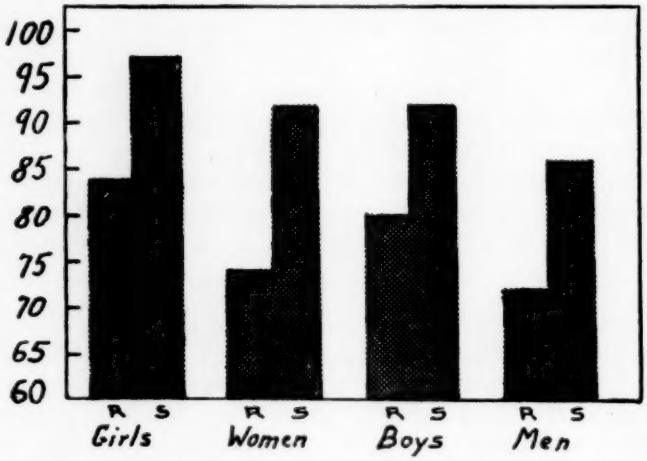

FIGURE I. Average pulse rates per minute in recumbent and standing positions of four groups in Table I.

TABLE I

AVERAGE AND STANDARD DEVIATION OF PULSE RATES PER MINUTE IN THE RECUMBENT AND STANDING POSITIONS OF CHILDREN AGED 9-12, OF 72 YOUNG WOMEN (BROGDON, 1933), AND OF 144 AVIATORS (SCHNEIDER AND TRUESDELL, 1922)

	Recumbent		Standing	
Girls	83.99 ± 1.147	σ10.195	97.19 ± 1.665	σ14.803
Women	74.1		91.8	
Boys	80.18 ± 1.099	σ 9.768	91.94 ± 1.336	σ11.873
Men	72.1		85.77	

standing pulse rates is 13.2 for girls and 11.76 for boys, indicating a poor reaction according to Crampton. However, when compared with the reactions of adult men and women, the children respond similarly, or show even smaller differences than normal adults. This may be due to the shorter height of the children and hence the smaller hydrostatic handicap.

The recumbent pulse rates are fairly low. Schneider and Truesdell (1922) have shown that people with a low recumbent pulse rate

tend to have a greater increase upon standing since there is a tendency for the heart rate to approach the average standing figure. They also consider that a slow pulse rate in the reclining and standing positions with a small difference between the two are usually indicative of excellent physical condition. Using this as a criterion, the subjects for these tests were normal.

The children were classified into groups according to age at their nearest birthday. The average of the pulse rates for each group is presented in Tables II and III. While the pulse rates are much the same for both sexes, the girls show a slightly higher rate than do the boys. With the girls, the pulse rate increases slightly between the ages of 9 and 12. For the boys it is the opposite.

Using the Pearson-Product-Moment method of calculation, all heart rates of the first tests were correlated with the corresponding heart rates of repeated tests on 21 girls and 24 boys. The figures indicate a high incidence of reliability, being 0.914 for boys and 0.915 for girls.

Figures II and III show that the range between the high and low levels of pulse rate is as much as 50 beats, but in no case could the

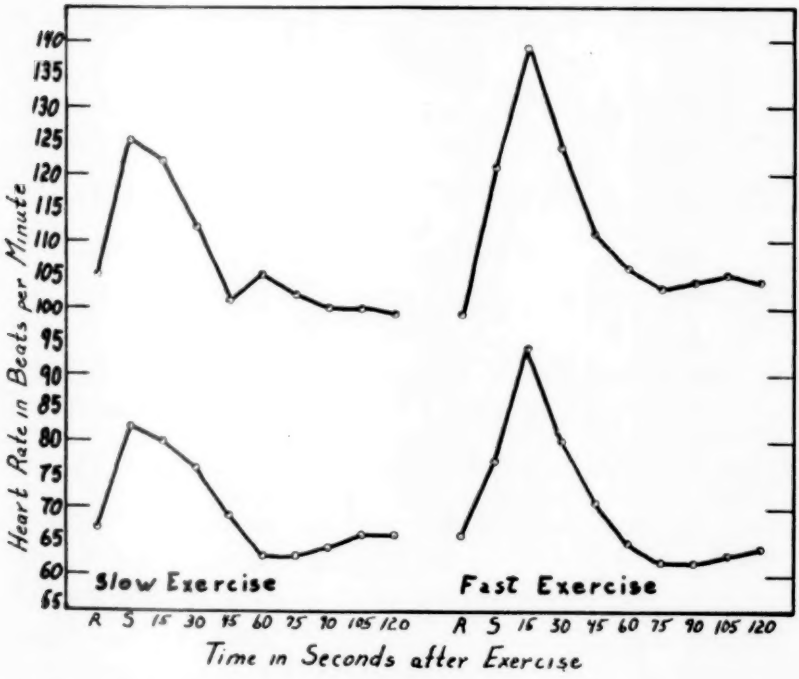

FIGURE II. Range of pulse rate reaction of girls. High and low pulse rates for all age groups were averaged.

TABLE II

AVERAGE PULSE RATES IN THE RECUMBENT AND STANDING POSITIONS BEFORE EXERCISE AND IN THE RECUMBENT POSITION AFTER EXERCISE FOR EACH AGE GROUP OF THE GIRLS.

Age Group	No. of Cases	Slow Exercise										Fast Exercise									
				Time in seconds after exercise										Time in seconds after exercise							
		R	S	15	30	45	60	75	90	105	120	R	S	15	30	45	60	75	90	105	120
9	26	81	91	104	90	84	81	80	80	79	80	80	90	118	99	86	83	80	78	78	79
10	32	83	96	104	90	84	82	80	81	81	81	81	93	118	100	88	83	80	80	80	82
11	16	90	109	105	96	86	81	86	84	84	83	83	107	121	111	90	86	83	82	82	83
12	5	89	101	102	91	88	87	81	81	82	86	86		119	102	93	87	90	89	89	87

TABLE III

AVERAGE PULSE RATES IN THE RECUMBENT AND STANDING POSITIONS BEFORE EXERCISE AND IN THE RECUMBENT POSITION AFTER EXERCISE FOR EACH AGE GROUP OF THE BOYS.

Age Group	No. of Cases	Slow Exercise										Fast Exercise									
				Time in seconds after exercise										Time in seconds after exercise							
		R	S	15	30	45	60	75	90	105	120	R	S	15	30	45	60	75	90	105	120
9	18	83	93	106	91	82	79	79	80	80	79	79	92	120	98	87	80	79	79	79	78
10	21	78	89	100	86	79	77	75	74	73	76	76	84	111	90	80	75	78	77	77	76
11	20	82	95	103	89	82	79	80	78	80	80	80	91	116	97	85	80	79	79	81	81
12	20	78	82	94	83	77	75	75	75	76	77	77	89	104	89	80	75	74	74	74	75

rate be considered abnormal. The highest pulse rates were not found among those children with histories of pneumonia, scarlet fever, or other serious diseases. Twice children with high pulse rates were absent from school with an upper respiratory infection the day

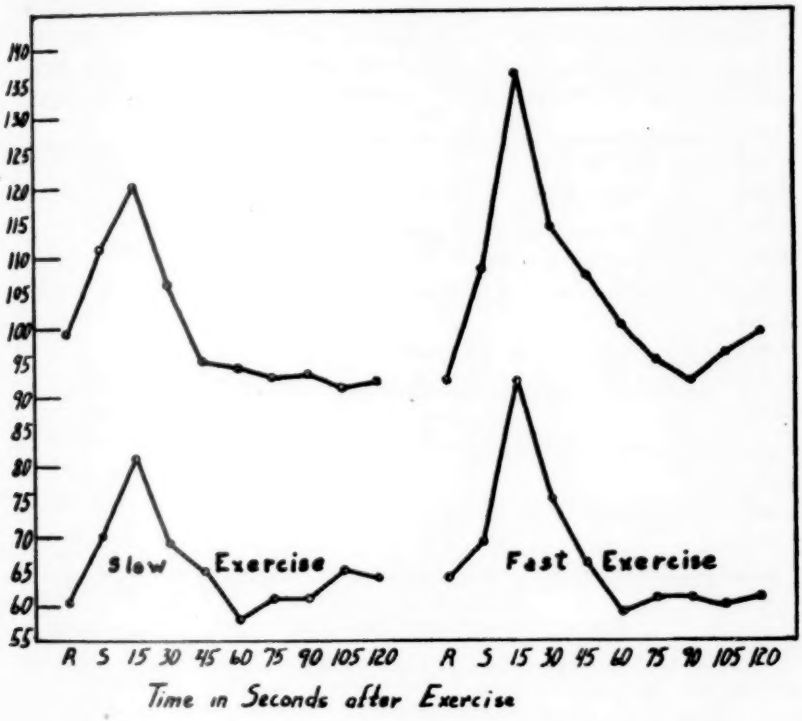

FIGURE III. Range of pulse reaction of boys. High and low pulse rates for all age groups were averaged.

following the experiment. When they were tested after recovery, the pulse rate was lower.

Again the girls showed slightly higher pulse rates than did the boys. This is better borne out by Figure IV showing the averages of all tests on the two sexes. This is also true of adults, women showing a higher pulse rate level than men. All subjects were at ease during the testing so any increase in pulse rate due to excitement should be a negligible factor.

The results indicate that children aged 9 to 12 show much the same reaction to exercise as to adults, in that there is a rectilinear relationship between the amount of exercise and the rise in pulse rate. Figures reported in this paper compare with those obtained by Shirley (1935) in testing children of the same age, although she

found resting pulse rates ranging from 78 to as high as 112 beats per minute. She also found no obvious sex differences.

In both sexes the pulse rate returns to normal or below within 45 seconds after the slow exercise and within 60 seconds after the fast exercise. The negative phase (when the pulse rate dropped below the previous recumbent level) during recovery occurred in 64.6 per cent of the tests on boys and in 65 per cent of the tests on girls. Lowsley (1911) reports that a negative phase appears frequently

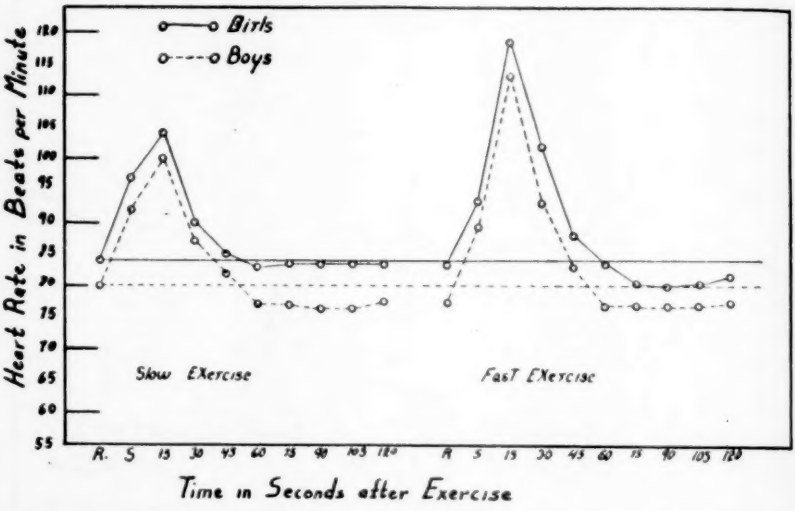

FIGURE IV. Average pulse rates of 79 heart-rate tests on boys and 79 tests on girls aged 9-13.

in all subjects after all types of exercise. Schneider and Truesdell (1922) found that 63 per cent of normal adult cases showed an average negative phase of 5.8 beats per minute after performing the Schneider test. Children used in these experiments were free from any heart defect that might have been discovered in the routine physical examination given all Minneapolis school children. The resting pulse rate may have been lower had the child been allowed a longer rest before exercise.

Schultz (1937) reports negative phases absent in healthy children after a stair-climbing exercise, but present in children with heart defects. There have been several indications that the negative phase is characteristic of the post-exercise response of pathological cardio-vascular systems, but its high incidence among the apparently normal does not justify giving it such an interpretation. At any rate, its frequent presence must be recognized and accounted for in the use of the ordinary cardio-vascular tests. The actual significance of

the appearance of the negative phase after exercise merits further research.

SUMMARY AND CONCLUSIONS

The purpose of this experiment was to determine the heart rate reaction of elementary school pupils to exercise under conditions such as they are found in the public schools. Seventy-nine tests were done on girls and a like number on boys whose ages ranged from nine to twelve.

The method involved a stool-stepping exercise similar to that used in the Tuttle pulse-ratio test.

Results give evidence for the following conclusions:

1. Heart rate tests in pre-pubertal children are reliable.
2. Children aged nine to twelve show no greater increase in heart rate on changing from the recumbent to the standing position than do adults.
3. Negative phase following exercise was present in 65 per cent of the cases. Other authors have shown the same conditions to be true of adults.
4. Children show a rectilinear relationship between amount of exercise and increase in pulse rate.
5. Girls show a slightly higher pulse rate than do boys of the same age.
6. In most cases the pulse rate returned to the resting level or slightly below within a minute after exercise.

Acknowledgments.—The author wishes to express thanks to Dr. Frances A. Hellebrandt, of the Department of Physiology at the University of Wisconsin, for advice and encouragement in the preparation of this manuscript, and to Miss Mildred Werschem for assistance in collection of the data.

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An Evaluation of a High School Tuberculosis Education Program

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THE problem of human behavior is a complex one. It is, nevertheless, the problem that challenges all health educators in the achievement of the final objectives for which their programs are planned. When the problem of why students behave as they do is raised in connection with the tuberculin testing of students in a program of tuberculosis education and case finding, it resolves itself into a number of pertinent questions such as the following:

1. What motives or influences operate to cause students to take or to fail to take the tuberculin test?
2. Does rational thinking based on knowledge of the facts of tuberculosis influence students to the desired behavior?
3. To what extent is the participation of students in the testing program determined by parents' decisions?
4. What educational techniques are responsible for helping to bring about the desired response?
5. Does each technique make the contribution expected of it?

The opportunity to seek the answers to these questions in an effort to determine why students behave as they do in taking or in failing to take the tuberculin test was presented in the case finding program that was conducted among senior students in the five high schools of Peoria last year. Collaborating with the schools in this joint project were the three community agencies responsible for the control of tuberculosis.†

The intensive educational program that preceded the actual testing of students in each school included the following:

1. A planning conference with a faculty advisory committee appointed by the principal.
2. A general faculty meeting for the education of teachers in the problem of tuberculosis and in the plans and purposes of the projected program.

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3. A meeting with teachers of senior students to distribute educational material, and to plan for integration with the regular curriculum and for special instruction in the home room periods.

4. A meeting with a student leader group selected to "develop public opinion."

5. A meeting with the staff of the school paper to plan cooperation in the program.

6. The tuberculin testing of the student leader group in advance of the other senior students.

7. The administration of a "Ten-Question Quiz" to all senior students by home room teachers to arouse interest in the problem of tuberculosis.

8. An assembly program for all classes timed to the minute, which included: talks by the doctors on tuberculosis and the objectives of the program; the moving picture, "Behind the Shadows;" demonstration of the tuberculin test, with two student leaders as subjects; two-minute talks by speech class students.

9. Personal contacts by teachers comprising the advisory committee with students failing to return signed request cards.

This program gave impetus to the development of activities, unique for each school, which it is unnecessary for the purposes of this paper to discuss.

When the program was completed we found 80 per cent of a total of almost 1200 students had taken the test. This outcome had been anticipated with interest, but it did not tell us to what extent our intensive educational program had itself influenced student behavior. Accordingly, we planned experimental studies* to help us to evaluate our educational procedures and to provide us with answers to our questions concerning student behavior. It is the purpose of this paper to describe those studies.

THE FIRST STUDY

The purpose of the first study to be described in this paper was to answer the question: "Is there a demonstrable relationship between the students' knowledge of the facts about tuberculosis and their behavior in taking or in failing to take the tuberculin test?" To state it in another way: "In general, do students who have mastered the facts about tuberculosis tend to behave wisely as indicated by their response to the offer of the tuberculin test?"

Our method of procedure in this study, at present incomplete, was as follows. A quiz of the multiple-choice type was prepared to include the questions of fact about tuberculosis. Ten questions from the teaching unit of the National Tuberculosis Association entitled

* Acknowledgement is made of the assistance in the questionnaire study of Dr. Glenn V. Ramsey of Indiana University, formerly of the Peoria Public Schools.

"Preventing Tuberculosis," were selected and slightly modified for use in this study, at the end of which the following question of attitude was appended: "If you were offered today the opportunity to have a tuberculin test and chest X-ray without cost to you or your parents, do you think that you would decide to take it?" The answers "Yes," "No," and "Doubtful" were given with the direction to check one of them.

The quiz was administered as the initial step in the intensive educational program by the homeroom teachers to 1,102 senior students from the five senior high schools in Peoria. (This represented all senior students with the exception of those who were absent on the day the quiz was administered).

Responses provided two items of information concerning each student; namely, his attitude toward taking the tuberculin test, and his knowledge of the facts of tuberculosis, as represented by his score on the ten-question quiz. We were able to determine, for example, the distribution in the group of students who answered all ten questions correctly of those who responded "Yes," "No," or "Doubtful" to the appended question of attitude. When the entire case finding program was completed, we obtained the information from the records indicating how each of these students *actually* responded to the offer of the tuberculin test.

We now had three items of information about each of more than a thousand students, as follows: (1) a score on the quiz which gave a measure of the student's knowledge of tuberculosis; (2) a response representing the student's attitude toward taking the test (expressed *before* the intensive program of education was begun); and (3) information indicating that the student *did* or *did not* take the tuberculin test.

In our present analysis we have related only knowledge as reflected by the scores with actual behavior.

For the students who took the tuberculin test, a comparison based on the scores achieved on the quiz reveals that percentages increased progressively from 63.8 for the group with a score of 6 correct answers to 83.7 for the group with a score of 10 correct answers. (The number of students scoring 5 or less was too small to warrant use). The possibility that the lower the scores of the students on the quiz (that is, the less they knew about tuberculosis as measured by the quiz) the less likely would they be to take the tuberculin test was tested for statistical significance. It was found that the difference is significant *only* when one compares the percentage of students with a score of 10 with that of students with a score of 9. In Peoria, therefore, students having at least as much knowledge as would be reflected in a perfect score on this quiz took the tuberculin test in greater proportion than others unable to achieve this score.

It is reasonable to assume that the same relationship between knowledge (100 per cent score on the quiz employed) and behavior (proportion of students taking tuberculin test) will be observed in any other comparable studies.

While utilizing legitimately the emotional drives to action, it seems to us desirable in a broad program of education to provide such scientific training as will lead students increasingly to base their behavior on logical reasoning.

As a next step in this study we propose in the coming year to repeat the procedure with our new group of senior students applying the quiz at the conclusion of our educational program as well as at the beginning. Of the group of students who fail to score 10 when the quiz is first given (that is, *before* the program of education is carried on) if there is a significantly higher proportion of students who take the tuberculin test among those who score 10 than among those who score less than 10 when the test is repeated, we have additional evidence to support a conclusion that knowledge definitely influences behavior.

It may be added that this study holds the promise of providing us with more information than was originally planned for it. Further analysis of a table of data representing for more than one thousand students the three items of information with regard to knowledge, attitude, and behavior may, we believe, suggest a new approach to the evaluation of our tuberculosis education programs.

THE SECOND STUDY

Our second study made use of the questionnaire method to obtain information from students concerning the causes for their behavior in the tuberculin testing program and their reactions to educational methods and techniques used in the program.

On separate questionnaire forms, distinguishable by their colors, four questions—the first two parallel, the third and fourth identical —were directed to two groups of students: (1) students who took the tuberculin test at school; and (2) students who failed to take the tuberculin test at school. (A third questionnaire was prepared for teachers covering the same material included in the student questionnaires the purpose of which was to discover teacher opinion of students' reactions and motives).

The first question sought to determine the extent to which students and parents were responsible for the decision in the students' taking or failing to take the tuberculin test. The aim of the second was to ascertain the extent to which various motives are responsible for the students' participation in the testing program. The third represented an effort to evaluate the various educational methods and techniques. A fourth question was included for the purpose of obtaining a picture of the students' reactions to the motion picture

film, "Behind the Shadows," which was selected for use in the program because of its particular suitability and general excellence. We wished to discover whether or not the scene showing the pneumothorax operation was presented in such a way as to cause unnecessary fear.

The questionnaires were administered to students by the home-room teachers in the high schools after the program of tuberculin testing had been completed in all schools. The material had been tried experimentally with two small groups at one of the schools to ascertain that the questions were clearly understood and to determine the length of time needed for answering. The purpose of the investigation and the directions for administering the questionnaires were discussed with the teachers and this information was prepared in typed form for reference by them. Students were informed of the purposes of the study. No names were placed on the papers.

Responses to the questionnaires were obtained from 568 students: 429 had taken the tuberculin test at school and 139 had failed to take the tuberculin test at school. (Several hundred students were unfortunately lost to us for the purposes of this study because of mid-year graduations).

Question 1 on the questionnaire designed for students who *did* take the tuberculin test at school reads as follows: "Who first made the decision that you should take the tuberculin test, you or your parents?" The answers "I did" and "My parents did" follow the question with blanks for checking. Question 1 for students who did not take the tuberculin test at school is varied only by being expressed in the negative.

Analysis of the responses to question 1 reveals that almost three-fourths of all *students* (72 per cent) first made the decision which led to their behavior in taking or failure to take the test. Almost one-fifth of all students reported that their *parents* first made the decision. A few students answered "both," and 8 per cent failed to answer the question.

In comparing the responses of the two groups (that is, those who took the tuberculin test and those who did not) it is interesting to observe that the majority (82 per cent) of the students who took the test state that they themselves made the decision whereas, among the group who did *not* take the test, the parents almost as often as the students first made the decision *against* the students' participation. The response to this question suggests to us the need for further education of parents if we are to succeed in testing a higher proportion of students in our testing programs.

Question 2 invites the students to select from among the items listed those which describe the reasons why they took the tuberculin test and to number them in the order of their importance in thus

influencing their behavior. The list includes the reasons or motives which we assumed might have influenced students in their behavior, for example: "I wanted to find out what it was like to take a tuberculin test;" and "Other students were taking the test—it seemed like the thing to do."

On the questionnaire for students who had failed to take the tuberculin test this question lists reasons for *not* taking the test, for example: "I was afraid that if I had a positive tuberculin test the X-ray might show that I have tuberculosis;" and "I was interested in other things at the time and didn't give it much thought." Many of the reasons listed on both questionnaires are based on the emotional drives to action. Opportunity is given for the students to list additional reasons. In order to minimize the possibility that the students' responses would be influenced by the order of the items in this and the following question, *two* forms of *both* questionnaires were prepared, differing only in the sequence of the items.

Among the students who took the tuberculin test the two reasons most frequently selected, representing more than 60 per cent of the choices were as follows: (1) "I wanted to find out if I had tuberculosis and I knew that the tuberculin test was the first step to take in finding out;" and (2) "I felt that I might have had contact at some time with a person who has tuberculosis." Other items were chosen with markedly less frequency than these two.

Among the students who failed to take the test, the two reasons selected most often were (1) "One or both of my parents objected to my taking the test;" and (2) "I was interested in other things at the time and didn't give it much thought." Other reasons were selected much less frequently. Here we find again, as in the response to question 1, that parental objection looms with considerable prominence as a reason why many of the group of students who did *not* take the test failed to do so.

Question 3, identical for both groups, lists eight special methods used in the intensive educational program and requests the students to number them in the order in which they helped them to understand the problem of tuberculosis. From the information that should be obtained in response to this question it was expected that we might in future programs make adequate use of the more helpful methods and improve the quality of others that appeared to provide less help than we judged they should.

Selected with greatest frequency by all students with almost one-third of the choices was the moving picture, "Behind the Shadows." Second in order of choice, with about one-fourth (27 per cent) of the choices, was "assembly talks by the doctors." "Printed materials" ranked third with 15 per cent and the other five in the order of frequency of choice were as follows: assembly demonstrations of the tuberculin test; students who took the tuberculin test early;

assembly talks by students; classroom teaching; and personal contacts of teachers.

Responses to this question indicate the effectiveness of the moving picture as a teaching method. It is with little surprise but nevertheless with some chagrin that we noted that "classroom teaching" and "personal contacts of teachers" held positions at the end of the list. The fact that these items made a comparatively small contribution, according to the students' responses, emphasized one of the weaknesses in our educational program.

The fourth question sought to obtain the reactions of students to our motion picture, "Behind the Shadows." It presented five pairs of statements, one the opposite of the other in each pair. The students were directed to check the statement in each pair which described how they had thought or felt when they saw the picture. It was of interest to note that, according to the responses, more than 8 out of 10 students found the picture interesting, were helped by it to understand tuberculosis, and gained from it a feeling of confidence in the tuberculin testing program. About 6 out of 10 expressed the wish to see the picture again. Our statements seeking information with regard to the fear reaction, namely, "No part of the picture made me afraid," and its opposite, "A part of the picture made me afraid," were not properly worded to furnish data for any valid conclusion.

The reports of the twenty-five teachers who worked closely in the educational program and submitted answers to the parallel questionnaires prepared for them provide too few data from which to draw any definite conclusions. On the whole, the judgments of this group with regard to student behavior and reactions coincide with the reports of the students. It was particularly interesting to find that teachers themselves, in judging the relative effectiveness of the several educational methods, placed at the end of the list, as the students did, the two items: "Classroom teaching" and "Personal contacts of teachers."

This study presents findings that cannot be accepted as completely objective. It is subject to the usual criticisms of inquiries of this kind. It is, however, an effort to obtain more accurate evidence than subjective opinions can provide.

The report of both studies is made in the belief that the experimental methods used and the findings presented may be found helpful to those who face the problem of student reactions in a case finding program.

The problem of behavior has many aspects and these studies make no attempt at covering the problem in a comprehensive way. Other studies are needed to verify the findings and to explore other areas of the problem. On the basis of an understanding of why students behave as they do when they take or fail to take a tuber-

culin test, we can expect to plan our educational programs with greater wisdom and with the prospect of increasing effectiveness.

SUMMARY

The following statements are presented in summary and conclusion:

1. Eighty per cent of the senior students took the tuberculin test in the first city-wide case finding program to be conducted in the high schools of Peoria.
2. The percentage of students taking the tuberculin test is not a measure of the extent to which an intensive program of tuberculosis education influences behavior.
3. Knowledge at least sufficient to answer correctly all ten questions on the tuberculosis quiz employed, reflects in a higher proportion of students taking the tuberculin test.
4. The majority of students (72 per cent) made the decision themselves as to whether or not they would take the tuberculin test.
5. Decisions made by students (relative to their taking or not taking the tuberculin test) were more frequently favorable to the taking of the test than were decisions made by parents.
6. The scope of the tuberculosis education program should be broadened to include more parent education.
7. Indifference or lack of interest represents an important reason why students did not take the tuberculin test, according to student responses.
8. The use of the motion picture, "Behind the Shadows," is an outstanding method of developing understanding of the problem of tuberculosis, as indicated by student reactions.
9. Further study is needed to determine the reactions of students to the pneumothorax scene in the motion picture, "Behind the Shadows."
10. Efforts are needed to increase the contribution of teachers and of classroom teaching to the program of tuberculosis education.

A Comparison of Physical Fitness Ratings as Determined by the Pulse-Ratio Test and Rogers' Test of Physical Fitness

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INVESTIGATORS have been experimenting for a great many years with tests and measures for rating physical condition and efficiency. Many of these have been useful within limits but still admitted limitations exist with all. No test of this type can be accepted as an infallible tool with which physical or athletic ability could be predicted without error. However, the results have considerable value when proper weight and consideration are given to them.

Two of the best known and most widely used of these are the Rogers' Physical Fitness Test and the Pulse-Ratio Test. The first is a measure of general strength and the other is based on the reaction of the heart to exercise. In other words, one attempts to classify a group according to muscular power, and the other according to the degree of efficiency of the organic functioning of the body.

Rogers' Test of Physical Fitness.—Rogers' test has been in use in many schools for a number of years. Briefly, it consists of a battery of seven individual tests the scores of which, when totaled, give a Strength Index. The tests include: lung capacity (cubic inches); grip of right and left hands (pounds of pressure); back lift (pounds); leg lift (pounds); push-ups on ends of parallel bars; and pull-ups or chins on hanging rings. The recording of the individual's height, weight, and age in years and months, is also required.

The first five of these tests are recorded as the scores appear on the apparatus or machines. The arm score is the product of the total push-ups and pull-ups and the "multiplier." The latter is found by dividing the weight by 10 and adding the height in inches less 60.

The arm score is added to the scores of the first five tests to obtain the Strength Index, which is the raw score. To get a Physical Fitness Index, the Strength Index is divided by the norm. Charts of norms are available for both boys and girls at two-pound intervals of weight and six-month intervals of age.[10*]

Many uses of this test are made in the public schools of Albany. Boys and girls having very low P.F.I.'s are given special attention,

* Superior figures refer to numbered Bibliography at end of article.

and individual programs are arranged as far as possible to correct the weaknesses discovered. Thus, the physical education classes are divided into squads more homogeneously, and individuals are better able to perform to their full capacities. City-wide track meets and ice skating meets operate on the Strength Index basis so that each entry competes only with his own relative strength group. The progress in physical capacity, and the results of a planned program, can be watched more closely through this objective medium.

The Pulse-Ratio Test.—Immediately following the first World War, there was a definite need for a dependable test of physical condition. Previously, the normal pulse rate has been used to indicate the individual's fitness but this failed to include the ability of the heart to compensate for muscular exercise, which is the real test of physiologic status. Hunt and others[1, 2, 3, 4, 5] found that by comparing the pulse rates before and after exercise, the general physical condition could be determined. The results were expressed as a pulse ratio which was calculated by dividing the two-minute pulse after exercise by the one-minute normal sitting pulse. The exercise was standardized by having the individual step on and off a stool one-third meter high for one minute at a uniform and predetermined rate. The pulse ratio for exercise doing twenty steps per minute was first obtained, and, after the subject rested until the pulse was back to normal, the exercise was repeated using forty steps per minute and the ratio was again calculated.

The subject's score was the number of steps per minute required to produce a 2.50 ratio. The two exercises performed would, in most cases, produce ratios one above, and one below 2.50. By linear interpolation, the 2.50 score could be found. The person using the greatest number of steps to get a 2.50 ratio would be considered the most physically efficient.

Experiments along the same line were continued at the University of Iowa where the test was employed to measure athletic endurance[6] and ability with much success. It was discovered, however, that simplification could be carried still further[7]. The pulse ratio itself was successfully used as a refined score in lieu of the number of steps required to give an arbitrarily selected ratio, thus eliminating the second or possibly more performances by the subject. Taking all factors into consideration, thirty steps per minute has been judged best for reliability and accuracy.

Home and laboratory-made devices can be set up for greater accuracy in the administration of the pulse-ratio test. An electrically driven polygraph with several accessories may be used to record the pulse, the number of steps taken, and the time consumed in the exercise. A metronome is useful to establish the rhythm for the correct number of steps per minute.[8] Where necessary, however,

manual pulse counting is believed satisfactory although slightly less exact than the mechanical methods.

Research into the history of the pulse-ratio test reveals the fact that all who have experimented with it to any great extent can see its potentialities. Likewise, individuals using the physical fitness test constantly claim its efficacy in classifying groups of subjects according to physical capacity. As previously mentioned, the former measures this capacity on the basis of the heart's reaction to a definite amount of exercise, while the latter is based on the strength of all muscle groups and their ability to coordinate in the performance of certain dynamic tests.

The main purpose of this study is to discover how a group of unselected subjects would compare on the two tests. In order to do this, it is necessary first to ascertain:

1. What the correlation is between the results obtained from an unselected group of individuals.
2. If the most favorable scores would be earned in both tests by the same pupils.
3. If a second testing, after an interval of several months, would show approximately the same results.
4. If the persons whose P.F.I. changes would have a similar change in pulse ratio.

The two tests were given to 56 junior high school boys in Albany, New York. The tabulations of physical fitness records used here were taken from the regular reports and findings of the fall and spring tests.

In giving the pulse-ratio test, all recognized influences which might tend to nullify the results were controlled as completely as possible. Each boy was tested at approximately the same time of day. They were required to rest for from ten to fifteen minutes while the procedure was being explained and the stepping rhythm demonstrated to them by a boy who had already performed the exercise. Several obstacles were encountered which necessitated a retest while, in a few cases, as many as three retests were required. The first boy, for instance, showed considerable fluctuation in the normal pulse rate, but after sufficient rest and a number of retakes it was found to remain constant. A school doctor, however, assured the writer that such a finding was to be expected with boys of junior high school age. Another cause for repetition was a boy whose pulse was so faint that only after four attempts could it be discerned, a difficulty that would have been eliminated by mechanical counting methods.

The second test was given in the same order so there was a similar intervention of time between the two for each boy.

The simplified method of scoring the pulse ratio was used: e.g.,

a boy with a normal "minute pulse" of 80 and a two-minute post-exercise pulse of 200 would have a ratio of 2.50.

Table I summarizes the findings of both the physical capacity and the pulse-ratio tests for the eighth-grade boys, and Table II does the same for the seventh-grade boys. The age, P.F.I., and weight are listed as they were recorded on the strength cards at the time of the tests. The pulse ratios were derived in the manner described previously.

The P.F.I.'s of the eighth-grade boys correlated .80 with their pulse ratios in the fall tests, as computed by the use of Spearman's rank-difference method. On the second test, six months later, the same group correlated .83.

The seventh-grade results were somewhat higher with .94 on the first tests and .90 on the second.

In three of the four tests (two for each class), the boys who had the highest P.F.I.'s also had the best (lowest) pulse ratios. In the fourth instance, the boy with the highest P.F.I. had the same pulse ratio as the boy with the second best P.F.I., the two being tied for the best pulse ratio of the class.

To demonstrate further the parallel results of the two tests, use of the median scores of the classes as units seems to give a fair indication.

TABLE I

DATA COLLECTED FROM 24 EIGHTH-GRADE BOYS

Sub. No.	Fall Test				Spring Test			
	Age	P.F.I.	Wt.	P.R.	Age	P.F.I.	Wt.	P.R.
1	13	164	86	2.06	13	141	98	2.12
2	15	133	99	2.12	16	126	109	2.14
3	14	132	93	2.07	14	149	107	2.02
4	14	125	144	2.09	14	127	156	2.17
5	14	123	80	2.14	14	125	86	2.14
6	13	116	80	2.18	14	102	92	2.28
7	14	114	96	2.18	15	92	114	2.22
8	14	112	86	2.24	14	120	96	2.21
9	13	109	92	2.25	14	96	106	2.31
10	13	107	112	2.15	14	96	119	2.24
11	14	106	85	2.21	15	112	98	2.18
12	13	105	88	2.23	14	93	97	2.23
13	15	101	110	2.18	16	94	136	2.25
14	13	100	116	2.16	14	101	126	2.28
15	13	100	107	2.27	14	98	114	2.33
16	14	99	110	2.19	14	91	123	2.28
17	14	99	126	2.21	15	92	142	2.25
18	13	97	82	2.19	13	92	92	2.25
19	14	91	116	2.21	15	90	134	2.33
20	13	90	89	2.23	13	97	97	2.20
21	13	83	119	2.42	13	74	137	2.43
22	13	81	81	2.39	13	74	95	2.43
23	13	80	135	2.41	14	78	149	2.34
24	14	68	156	2.43	15	57	197	2.59

TABLE II

DATA COLLECTED FROM 32 SEVENTH-GRADE BOYS

Sub. No.	Fall Test Age	P.F.I.	Wt.	P.R.	Spring Test Age	P.F.I.	Wt.	P.R.
1	13	136	85	2.05	13	138	92	2.06
2	14	129	81	2.05	14	146	86	2.05
3	14	128	95	2.09	15	138	102	2.08
4	13	120	94	2.11	13	135	100	2.12
5	11	120	85	2.14	12	122	92	2.17
6	12	116	72	2.13	12	113	79	2.17
7	12	113	90	3.30	13	109	94	2.20
8	12	109	96	2.13	12	109	101	2.18
9	12	108	76	2.22	13	112	78	2.21
10	14	107	95	2.14	15	108	106	2.15
11	13	107	89	2.20	13	107	94	2.19
12	12	104	73	2.16	13	104	79	2.18
13	12	103	98	2.21	13	100	105	2.21
14	12	102	85	2.21	13	102	86	2.17
15	13	99	75	2.20	13	99	81	2.24
16	12	97	135	2.27	12	109	146	2.18
17	13	95	107	2.21	13	100	121	2.24
18	12	95	86	2.26	13	104	87	2.23
19	12	94	82	2.29	13	100	86	2.20
20	12	93	86	2.24	13	104	90	2.18
21	12	92	113	2.34	13	94	122	2.29
22	13	91	113	2.55	13	90	122	2.34
23	14	91	93	2.34	15	97	100	2.18
24	13	90	103	2.31	13	98	112	2.22
25	12	90	100	2.30	13	94	101	2.27
26	13	89	104	2.43	13	79	113	2.39
27	13	88	96	2.40	13	95	102	2.31
28	12	85	108	2.29	13	87	114	2.41
29	11	85	96	2.35	12	88	110	2.40
30	12	84	115	2.29	13	96	120	2.28
31	12	70	108	2.39	13	76	117	2.32
32	12	70	134	2.39	12	72	144	2.38

TABLE III

COMPARISON OF THE MEDIAN SCORES OF GRADES SEVEN AND EIGHT

	Eighth Grade P.F.I.	P.R.		Seventh Grade P.F.I.	P.R.
First test	103	220	First test	96	223
Second test	96	225	Second test	101	220.5
	— 7	+ 5		+ 5	— 2.5

Of the 56 boys in both classes, only 13 had a dissimilarity of change. Ten who showed improvement in the physical capacity test had poorer pulse ratios, while 3 who improved in pulse ratio had a lower P.F.I.

Correlating age and the pulse ratio, the results in the seventh grade were: –.02 in the first test and –.06 in the second. The eighth grade in the first test correlated –.41, and –.25 in the second. In age, the boys were ranked with the youngest at the top with the lowest pulse ratios, whereas, the results would have been positive

had the oldest been ranked first. At any rate, the findings support the conclusion of Tuttle and Skien[9] that, "When compared on the basis of age, there are no significant differences in efficiency."

As might be expected, weight tends to compare more closely with the pulse ratio but still without great significance. Correlations for these were: seventh grade, .61 in the first test and .54 in the second; eighth grade, .17 in the first and .35 in the second. The lightest boys were ranked first along with the lowest pulse ratios for these computations.

CONCLUSIONS

According to the evidence resulting from this study, there is no doubt as to the close relationship existing between the physical ratings obtained by the physical capacity test and the pulse-ratio test. The lowest correlation of the two tests for the two classes was .80 and the highest .94, the best proof of comparison available for the time and personnel allotted.

Further indication of the similarities of the results of the tests is the fact that the eighth-grade boy who ranked third in the physical capacity test and second in pulse ratio in the fall, improved sufficiently to rank first in both in the spring tests. At the same time the boy who had ranked first dropped to second in both tests. A similar result was found with the seventh-grade class.

The comparison of the median scores shows that the eighth-grade boys as a group decreased the same approximate amount in both tests, while the seventh grade showed a similar improvement in each.

Where only a slight change by individuals occurred in the second testing in the strength test, the change in pulse ratio in some cases was similar in quantity but in the opposite direction. This could bring up the question of which is probably the more accurate. Defense of the pulse-ratio test, in spite of the fact that it is not a battery, seems to the writer to be more feasible. In the strength test, the pupil is expected to utilize all the dynamic power he can muster several different times, which fact may tend in some instances to affect the results. At least the instructor cannot be positive that the pupil's "attitude" is a constant factor. On the other hand, the exercise performed in the pulse-ratio test does not tax the person's strength to capacity and thus the degree of voluntary effort is not so vital a factor.

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Common Postural Defects of College Freshmen

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As part of the physical education program which operates under the supervision of the University Health Department, an orthopedic examination with special reference to proper body mechanics has been made of each member of the incoming freshman class during the fall.

This study is based on the results of the orthopedic examinations of 11,088 freshmen entering Yale University over a period of 13 years, including the classes 1930-1942. The purpose is to point out those postural defects which are most prevalent at the onset of college life. It is felt that the presentation of the findings of the orthopedist on such a large group over a period of years is of value. Furthermore, the results should be of interest because of the selection and general health of the group as a whole. With a large percentage coming from preparatory schools where some attention must have been devoted to physical development and health education, many of these students should be posture conscious and have health habits above the average.

In a previous study, Dr. Robert J. Cook [1] reported the orthopedic examinations of 1,393 freshmen of the classes of 1923 and 1924 at Yale University. These classes were the first to be examined under the new program in body mechanics at Yale. Dr. Cook's report revealed the low percentage of normal posture among students at that time. He called attention to the fact that 96.5 per cent of these men had rounding of the shoulders; that over 53 per cent had an increased anteroposterior spinal curvature; and that over 50 per cent had some lateral curvature. He found also that the chest was normal in 43.7 per cent of the cases while in over half of the group it was flattened to some extent. The abdomen was prominent beyond the normal in 41.7 per cent, and 82 per cent showed evidence of pronation of the feet to some degree.

1 R. J. Cook, "Report of the Orthopedic Examination of 1,393 Freshmen at Yale University," *The Journal of Bone and Joint Surgery*, 4 (April 1922) 247-65.

AIM OF EXAMINATION

The aim of the posture examination is to determine the mechanical efficiency of the use of the body as an integral machine. A thorough knowledge of the structure and mechanics of the body and the variations, both structural and functional, from the normal is an important prerequisite to the determination. The examination must be careful and thorough; if done by the same examiner following definite standards, the findings should be accurate and reliable.

TERMINOLOGY AND TECHNIQUE[2]

As there are different views on what is good or poor body mechanics, it is necessary to make a brief clarification of terminology and technique involved in the orthopedic examination as given at Yale University so that its particular point of view on body mechanics will be understood.

GENERAL CARRIAGE

For purposes of examination, general carriage is arbitrarily divided into the following groups:

Good posture. Those individuals who have as nearly ideal posture as can be determined.

Fair posture. Those individuals with mild or moderate postural defects but with no structural deformity.

Poor posture. Those who have extreme or marked postural defects, and who have definite structural variations.

ANTEROPOSTERIOR DEVIATIONS

The specific postural defects are judged approximately by the doctor and arbitrarily divided into four degrees of measurement:

Ideal. Men who have ideal posture and segmental alignment and show no need for corrective work.

First Degree. Men who have mild defects which are not considered serious enough to require corrective measures.

Second Degree. Men who have moderate defects which are obviously in need of correction.

Third Degree. Men who have marked defects which require definite individual attention.

In the examination, the anteroposterior deviations have been considered in the following sequence:

Neck Forward.—The structure of the soft tissues and muscles about the neck is such that the line of the front of the neck from the chin to the sternum is approximately vertical when the body is in good posture. This line can be made to tilt forward from the perpendicular by thrusting the head forward, and the degree of tilting can be judged. In some cases the posterior neck line may serve as a check on the judgment of the anterior line.

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[2] The writers are indebted to Charles C. Thomas, Publisher, Springfield, Illinois, for permission to use in this section material from *The Diagnosis and Treatment of Postural Defects* by W. M. Phelps, and R. J. H. Kiphuth, pp. 78-125.

Shoulders Forward.—In the ideal posture, the position of the shoulder girdle is such that a plumb-line from the tip of the mastoid passes through the tip of the acromion. An examination of the distance between the scapulae, viewing the subject from the back, is also of value in grading the shoulder position. If the examiner stands directly behind and looks downward over the shoulder of the subject, the line from the tip of the shoulder to the sternum, below the clavicle, can be observed. When the shoulders are in their normal position, this line is practically straight, but when the shoulders are forward, it becomes concave. The position of the clavicle and its prominence can be observed; in thin people the clavicle is more prominent, but its relative prominence is such that as the forward position of the shoulders increases, the prominence of the clavicle becomes greater.

Overcarriage.—Dr. Winthrop M. Phelps, orthopedist during ten of the thirteen years which this study covers, felt that overcarriage was a fairly common postural defect and, as it had not been recorded on our previous examinations, decided to add it as another defect to be considered, beginning with the examination of the class of 1932. This defect may be defined as a position in stance characterized by the following points:

1. The legs, instead of being perpendicular or nearly perpendicular when viewed in profile, are definitely tilted forward.
2. There is no increase in the forward tilting of the pelvis.
3. The trunk is inclined backwards from the perpendicular.

This defect depends upon abnormal length of the ilio-femoral ligament, either congenital or acquired, which allows a greater amount of hyperextension in the hip than normal and thus brings about a postural defect in stance described by the term "overcarriage."

Kyphosis and Lordosis.—A study of the spinous processes of the dorsal and lumbar vertebrae will show that the spines of the first and second dorsal are almost perpendicular to the vertebral laminae and that they become more angulated downwards so the sixth and seventh lie almost vertical. From this point, they become again more horizontal and in the lumbar region they are longer and horizontal. This fact makes possible the "flat back." The normal dorsal curve is most prominent backwards at the level of the seventh to eighth dorsal vertebrae where the spinous processes are almost vertical. The lumbar spinous processes are longest at the level of the third lumbar vertebra and become shorter below as the lumbar curve swings back. In the ideal posture, therefore, the back has apparently no curve between the first dorsal and the fifth lumbar vertebrae. A string stretched from the first dorsal vertebra to the fifth lumbar vertebra remains straight in the anteroposterior plane. The dorsal vertebrae do not force it backwards and it does not lie away from the lumbar vertebrae when stretched taut. It makes contact with all the spinous processes from the first dorsal vertebra to the fifth lumbar.

A first degree increase in dorsal curvature, kyphosis, is one in which there is a slight curving of the taut string. In a second degree kyphosis, the string definitely curves backward with the spine. In marked cases (third degree) the curve is more prominent.

In a first degree lordosis, the lumbar curve deviates from the string so that one finger can pass beneath the string at the maximum depth of the curve. A second degree lordosis permits two fingers to pass under the string. In third degree cases there is a distance of approximately two to four inches from the string at the deepest point.

Reverse Curves.—During the examination of such a large number of subjects, it has been found that with some individuals the taut string does not make contact with the spine in the mid-dorsal region and is bowed posteriorly in the lumbar region. There is, therefore, a hollow in the dorsal region and a prominence in the lumbar region. The term "reverse curves" is used to describe this particular position. While this is a comparatively uncommon variation, it should be watched for with great care as some of the exercises used for postural correction are contra-indicated in this condition. This defect is seen in individuals with considerable ligamentous relaxation, or in very flexible individuals who have been over-corrected, and presents essentially an extreme flattening of the pelvis with its brim being more nearly horizontal than the usual pelvic angle.

Scoliosis.—Lateral deviations from normal posture are confined almost entirely to the trunk and are grouped under the term scoliosis. An examination of the symmetry of the body as a whole, including the level of shoulders and of the hips, precedes the examination of the spine for evidence of a lateral curvature. The actual lateral deviation is judged by a string stretched from the seventh cervical to the fifth lumbar vertebra. If all of the curve lies to one side of the string, it is noted as a single or "C" curve. If part lies to one side and part to the other, it is recorded as an "S" curve. The approximate amount of the curve can be determined by palpating the spinous processes and measuring and naming the spinous process at the greatest distance from the taut string.

Chest.—Changes in contour of the thorax take place with respiration. The examiner will decide whether the chest is being held in a position near the mid-point between expiration and inspiration or whether it is in a position of more or less full expiration. While, as a rule, chests will be found to vary from normal to the usual grades of flatness, there may be in a few cases significant deformities such as pigeon breast, funnel breast, rachitic rosary, and Harrison's Groove.

Abdomen.—Variations in abdominal prominence are very frequent. In the fat individual the examiner tends to be led astray

by deposits of subcutaneous fat. This fat is usually seen most markedly at the lower border of the abdomen and may be somewhat pendulous over the symphysis pubis. This simulates to a certain degree the relaxation of the lower abdomen seen in association with a forward tilted pelvis. The examiner may readily determine by palpation whether the abdominal prominence is due to relaxation of the abdominal wall itself or to a deposit of fat. This lower abdominal relaxation may be present in the absence of any lowering of the thorax especially in young children, but it usually is associated with depression of the chest, a flattening of the thorax, and a resultant forward position of the shoulders.

A prominence of the upper abdomen is occasionally seen with no prominence below. This is usually in the athletic type and is muscular in the main. Finally, there is the relaxation of the whole abdomen, in which it is curved out from the rib line to the pubis. This is the commonest type seen in small children. The degrees here are the same as those applied to other variations. The flat abdomen, with a straight line extending from the symphysis pubis to the xyphoid process is taken as the ideal condition. First degree prominence is recorded where only a slight curve is seen; second degree prominence, when the abdomen is definitely prominent; and third degree, when there is a marked bulge. In cases where the prominence is especially low or high, this fact is noted.

Feet.—The term "flatfoot" is very misleading. The condition has been divided by some into static flatfoot, when the sole of the foot seems flat only under weight bearing, and rigid flatfoot when the flatness remains even after removing the weight from the foot. It will be found, however, upon examination of a large number of feet, that "flatness" is usually static due to pronation which can be corrected at will by the individual.

If the subject stands with bare feet parallel and the amount of weight divided equally on the two legs, the examiner is able to determine the pronation by sighting down the line of the heel cord. If this line is perpendicular and bisects the middle of the heel, then pronation is not present to any important degree. If, however, the line of the heel cord curves inward as it reaches the heel or apparently is nearer the medial border of the heel than the lateral, then pronation is present and the degree can be judged.

In examination of the feet, a distinction should be made between a pronation or tilting inward of the ankle, and a real flattening of the longitudinal arch which does not disappear with correction of the pronation.

There is occasionally seen an abnormality of the foot in the opposite direction, in which the heel cord line seems more toward the

outside of the heel than in the midline. There is associated with this an apparent increase in the height of the arch, which assumes average height on correction of the defect. This abnormality may be due to muscle imbalance and a varus contracture of the forefoot. Such a condition is noted in the examination as a supinated foot.

TABLE I

ORTHOPEDIC EXAMINATION RESULTS, 11,088 YALE UNIVERSITY FRESHMEN, CLASSES 1930-1942

	Degree	Per Cent	
General carriage	Good	2.1	
	Fair	93.9	
	Poor	4.0	
Neck forward	0	25.2	
	1	49.6	
	2	21.6	25.2
	3	3.6	
Shoulders forward	0	75.8	
	1	21.8	24.2
	2	2.4	
Overcarriage	0	75.7	
	1	22.4	24.3
	II	1.9	
Kyphosis	0	50.9	
	1	35.7	
	2	11.6	12.7
	3	1.1	
Lordosis	0	35.3	
	1	36.7	
	2	22.2	27.3
	3	5.1	
Reverse curves		0.7	
Scoliosis	0	71.9	
	¼"	16.1	
	½"	9.4	12.0
	¾"	1.8	
	1"+	0.8	
Chest	Normal	75.6	
	Flat	19.1	
	Pigeon		
	Funnel		
	Rachitic	5.3	
	Rosary		
	Harrison's		
	Groove		
Abdomen	Normal	65.4	
	Prominent	33.6	34.6
	Protuberant	1.0	
Flat feet	0	58.1	
	1	33.7	
	2	5.5	6.0
	3	0.5	
	Supinated	2.2	

SUMMARY

Table I gives the summary of the results of the orthopedic examinations of 11,088 Yale University freshmen covering a period of thirteen years. The record shows that there is a surprisingly large number of individuals at the college level who could benefit from body mechanics education and corrective work not only from the standpoint of health and physical efficiency but also from that of good appearance. The degrees of defect sufficient to warrant corrective efforts have been bracketed, and the combined percentage is shown at the right of the "per cent" column in Table I. Due to the frequent association in one individual of two or three of these more marked deviations from normal the group requiring corrective work in varying degrees averages between fifty and sixty per cent of the men examined.

CONCLUSIONS

In view of the prevalence of faulty body mechanics, and in view of the desirability of good body mechanics, it is obvious that the matter merits more attention in our educational system. Throughout school life, the physical development of the student should be closely followed. It is only natural that physical education should consider the important problem of posture as one of its own. The health service as part of its program should provide an orthopedic examination for each student and a definite follow-up program for the correction of postural defects. A program of physical exercise without attention to body mechanics cannot be relied upon to promote good posture, for despite participation in athletics many individuals show evidence of marked defects on examination.

While the present study has been primarily concerned with the diagnosis of postural defects by the orthopedist, the writers have another study under way dealing with the results of body mechanics education and corrective work among the subjects included in the present paper. In the follow-up paper the writers will supplement the re-examination findings of the orthopedist with objective measurements from the posture photograph[3] taken of each student. There is need for additional studies investigating possible relationship of posture to disease, organic efficiency, mental attitudes, and scholastic achievement.

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3 J. S. Wickens and O. W. Kiphuth, "Body Mechanics Analysis of Yale University Freshmen," *Res. Quart.*, 8:4 (Dec. 1937) 38-48.

A Test of Diving for Use in Beginning Classes

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A CURRENT and desirable trend in physical education is found in the use of objective tests for measuring achievement in the various activities of our field. There has been in the past no test, known to this writer, of diving ability which could be used in a beginning class. In the official method of rating,[1] it is too difficult for most people to pass more than one or two dives, and there are many people who can do none on this list. We should have a test simple enough for beginners who learn only a little, yet extensive enough for those who learn rapidly. It is common experience in even the large universities to have only a very small number of women and men who can meet the requirements of the official diving rules. A test that is too difficult and gives no score is not a good test. Another objection to the official rules is that they introduce much nervous tension by allowing only one trial for each dive. The third difficulty with these rules, and the most important, is that a diver's score weighted according to agreed difficulty, actually may be weighted nothing at all or weighted very much according to the standard deviation of the scores, which apparently is not known.

DIVING TEST

The following test of fifty items is proposed as one which is objective, valid, and reliable. The test items range from simple stunts to difficult dives. The individual's score is the number of items passed according to the requirements given. A subject is given as many trials as desired on each item.

Definition of Terms.—Entrance into the water "head first" means that the hands enter the water first, then the head, and then the hips. These must be consecutive and not simultaneous. (As long as the hands and head hit the water first this requirement is met even though the dive may be quite flat or the knees bent or the legs apart, etc. In other words any headfirst entry short of a "belly flop" counts.) "Straight headfirst" implies an excellent entry into the water in this consecutive order: hands, head, hips, knees, feet, with no body bends at waist, hips, or knees. The feet must enter the same opening in the water as that made by the head.

Entrance into the water "feet first" means that the feet enter the

[1] *Aquatics with Official Rules for Swimming Meets*, National Section on Women's Athletics of The American Association for Health, Physical Education, and Recreation (New York: A. S. Barnes and Co., 1940).

water first, then the hips, and then the head, in consecutive order, not simultaneous. "Straight feet first" implies an excellent entry into the water in this consecutive order: toes, knees, hips, shoulders, with no body bends at waist, hips, or knees, and with the hands touching the sides of the body. The head must enter the same opening in the water as that made by the feet.

TEST ITEMS

1. Standing dive from pool edge—enter straight head first.
2. Standing dive from pool edge with return to surface—enter straight head first, keeping hands and arms in same relative position until return to surface.
3. Standing dive from pool edge to bottom of pool—enter straight head first and touch the bottom at an 11-foot depth.
4. Sitting tuck position with fall into the water from the 1-meter board—remain completely tucked (hands grasping shins, and forehead on knees which are drawn up to chest) until under the water. Any starting position.
5. Standing dive from board—enter straight head first.
6. Standing feet first dive—body must be in the straight feet first position in air and at entry. Jump from board, do not step.
7. Forward approach—must include at least three steps and a hurdle, landing on both feet. Accompanying arm motion must be smooth—no pauses in entire approach. Toes must be pointed to the board during the hurdle before landing on the end of the board.
8. Running feet first dive—combine requirements of numbers 7 and 6.
9. Springing the board—rise from the board at least six inches with five consecutive jumps, using the arms to help in gaining height.
10. Rocking chair—sit on the end of the board facing the water, and by rocking backward with feet over head, gain enough momentum to rock forward head first into the water. Enter head first.
11. Springing the board with a double tuck position—same as number 9 except that a tuck position must be assumed when in the air. Knees must be bent when hands touch shins in tuck position. Do four consecutive tucks.
12. Running front tuck dive—enter straight head first after assuming a tuck position in the air (knees bent, hands on shins).
13. Forward dive over pole hip high—enter straight head first, clearing the pole.
14. Elementary front jackknife dive (standing)—bend enough at the hips to have the hands below the knees (though not necessarily touching the legs) at the time of the bend. Enter head first.
15. Running jackknife dive—enter straight head first. Keep knees together and straight after leaving the board. Wrists below knees at time of jackknife bend.
16. Advanced jackknife dive—same as number 15 except for these requirements: actually touch ankles, or top of arch, and enter water within 6 feet of the end of the board.
17. Elementary back jackknife dive—(taken to the side of the board)—enter head first with the head entering the water *behind* the starting point. Must have some bend at hips.
18. Back jackknife dive—same as number 17 except that the dive is taken straight back from the end of the board.
19. Advanced back jackknife dive—same as number 18 except that there must be a straight head first entry and knees must be kept together and straight after leaving the board.

20. Back approach—must include at least three steps, correct direction of turn (free leg swings out over the water, not over the board), and no hesitations.

21. Back spring to the water feet first—use arms in the spring-up from the board; jump, do not step, from the board, and enter the water straight feet first.

22. Back spring to the board—from the back stance, spring upward from the board (using arms smoothly to assist) with knees straight and toes pointed to the board. Toes must be at least 6 inches above the board when in the air. Return to the board.

23. Back bend—from the back stance position, bend backward and enter the water head first.

24. Elementary back dive—same as number 23, but hold straight head first position in air and at entry.

25. Back dive—same as number 24 but use some preparatory spring with smooth use of arms.

26. Advanced back dive—same as number 25, but done in two parts: (1) keep the head up, eyes forward, as body is rising from the board, then (2) head is thrown back when the crest of the height is reached. Enter straight head first within 6 feet of the board (no twist). Toes pointed throughout the dive.

27. Standing forward dive with an arch—when in the air look distinctly forward and up. Look down just before entering straight head first. Lead with hands throughout the dive.

28. Butterfly dive—same as number 27, either running or standing, but with hands on hips when in the air. Enter straight head first.

29. Running swan dive—must have the body arched in the air. No body bends, arms above shoulder height and extended to sides, head up. The regular position of the swan dive in the air must be attained even if only for a moment. Enter head first.

30. Advanced running swan dive—same as number 29, entering straight head first.

31. Running forward half twist, feet first—turn at least 180 degrees, and enter straight feet first.

32. Quarter twist—assume a distinct swan position in the air, followed by a turn on the long axis of the body of at least 90 degrees. (Shoulders determine degree of turn.) Enter head first.

33. Half twist—same as number 31, but turn at least 180 degrees.

34. Jackknife with a quarter twist—assume a distinct jackknife position in the air, followed by a turn of at least 90 degrees. Enter head first.

35. Elementary jackknife with a half twist—same as number 33, but turn at least 180 degrees.

36. Neck stand—lie with back to board and head at the "water" end of the board. Bring the feet up over the head, aim them toward the water, and enter the water feet first. Hands must be at sides at time of feet first entry.

37. Handstand dive—enter straight head first. Entire body must clear the board.

38. Handstand feet first dive—enter feet first, after assuming the handstand position on board and holding on until feet complete the arc and point toward the water.

39. Rocking chair (3-meter board)—enter head first.

40. Neck stand (3-meter board)—enter feet first, see number 36.

41. Forward fall dive (3-meter board)—from an erect forward standing position with arms extended over head, fall forward, entering the water head first. Remain perfectly stiff throughout the fall.

42. Backward fall dive (3-meter board)—same as number 41 except that the fall is taken from a backward standing position.

43. Tuck and roll with a spring from edge of pool (a forward somersault in the air from the edge of the pool, turning in the tuck position)—turn at least far enough forward so that the head clears the water and the back strikes the water first.

44. Forward somersault (1-meter board)—turn a forward somersault in the air so that the feet hit the water first.

45. Backward somersault—turn a backward somersault in the air so that the feet hit the water first.

46. Half gainer—only requirement: enter head first.

47. Full gainer—only requirement: enter feet first.

48. Back half twist—from the back stance position, make a half twist, entering the water straight head first. Do not twist until after leaving the board.

49. Forward one and one-half somersault—only requirement: enter head first.

50-51-52, etc. Perform any of the standard dives (including also the handstand dive and the handstand feet first dive) from the 3-meter board. No requirements as to form except that the dive is recognizable to the judges, and has a head first or feet first entry depending on the dive selected. If, for instance, a jackknife dive is done with very little bend at the hips, it would not be evident to the judges whether it was intended to be a jackknife or a plain forward dive.

A question may arise concerning the necessity of a distinction to be drawn between those who pass a test item on the first trial and those who require many trials. The subject who passes on the first trial goes on to the next test item, thus passing more items with an equal number of trials than the poorer diver. The test is unlimited for a beginning class in that all the standard dives may be attempted from the high board. It is to be understood that the subject who fails a test item may go on to the next one without passing the previous item; a person may make one or more attempts at all the tests.

It was not desired to weight any of these test items, as the progressive steps are approximately equal. The test items do not weight themselves automatically, for the score on each test is either zero or one, and this does not permit a range of greater than one. The more difficult dives are divided into parts as, for example, the forward jackknife dive in tests 10, 11, and 12. A very elementary performance of this dive is passed under test 10; a better performance under test 11, and an advanced performance under test 12. Perfect performance in the somersaults, gainers, and high board dives is not required. The front somersault dive, for example, requires only that the subject make one turn in the air and enter the water feet first.

EVALUATION OF TEST

Subjects.—The group of subjects used in this study was composed of college women between the ages of 18 and 23, selected from 6 ele-

mentary diving classes at the University of California.* Only those subjects, 26 in all, were used who continued the course throughout one semester, and who were able and willing to take the test.

Validity.—The validity of this test of diving ability was determined by comparing the results with a rating by expert judges who used the official 10-point rating rules. This rating was given at the end of the semester. Three experienced judges did the rating. Each diver selected eight dives according to official rules and received as her score the average of the three judges' ratings, multiplied by the proper degree of difficulty for each dive. The divers were ranked according to their total scores. The ranking position of the divers was then compared with the ranking position of these same divers on the objective test proposed in this study. A coefficient of +.94 (P.E. ±.019) was obtained, meaning that the test was reliably valid.

Reliability.—The reliability of this test of diving ability was determined by correlating the sum of the scores on the odd tests with the sum of the scores on the even tests. The whole test was thus divided in half, and the odd half compared to the even half. A correlation coefficient of +.90 (P.E.±.02) resulted. This was the reliability of half the test, and was raised by the Spearman-Brown formula [2] to give a correlation of +.95 (P.E.±.01) for the whole test. The split-half procedure of determining reliability was used because of the impossibility of giving a retest of this diving test which extended over a semester.

Objectivity.—The objectivity of this test of diving ability was determined by having three judges use the test simultaneously on four divers. Of the three judges—Esther Johnson, Eugenia Kennan, and the writer—one was inexperienced and two were experienced judges of diving. The one inexperienced judge was used in order to see how her decisions compared with those of the experienced judges. No practice in judging was given (except for the writer's practice). The directions for each dive were read to the judges by the writer before each test item was performed. Four subjects took the test in one period. Owing to lack of time, dives 2, 3, 12, 13, 22, 28, and 40 and the optional dives from the high board were omitted as these contain approximately the same judging points as in the other dives (e.g., number 39 is judged the same as 40). Failure to attempt a dive was judged not passed.

With 42 dives and 4 divers, there were 168 chances for agreement. Table I gives an analysis of these chances.

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* This study was based on a master's thesis done at the University of California.

[2] Henry E. Garrett, *Statistics in Psychology and Education* (New York: Longmans, Green and Company, 1926).

TABLE I

ANALYSIS OF CHANCES FOR AGREEMENT ON TEST OF DIVING ABILITY

Judges	Number of Agreements	Per Cent of Agreement
All three judges	148	88.9
Two experienced judges (Kennan and Bennett)	156	92.9
Bennett and Johnson	153	91.1
Kennan and Johnson	155	92.3

The two experienced judges were in better agreement, as was reasonable to expect. Figure I shows the objectivity of the 42 test items when judged by two experienced judges.

SUMMARY

There seems to be a need for an objective test of diving ability for use in beginning classes in springboard diving—a test that is simple enough for beginners, that permits several trials, and that does

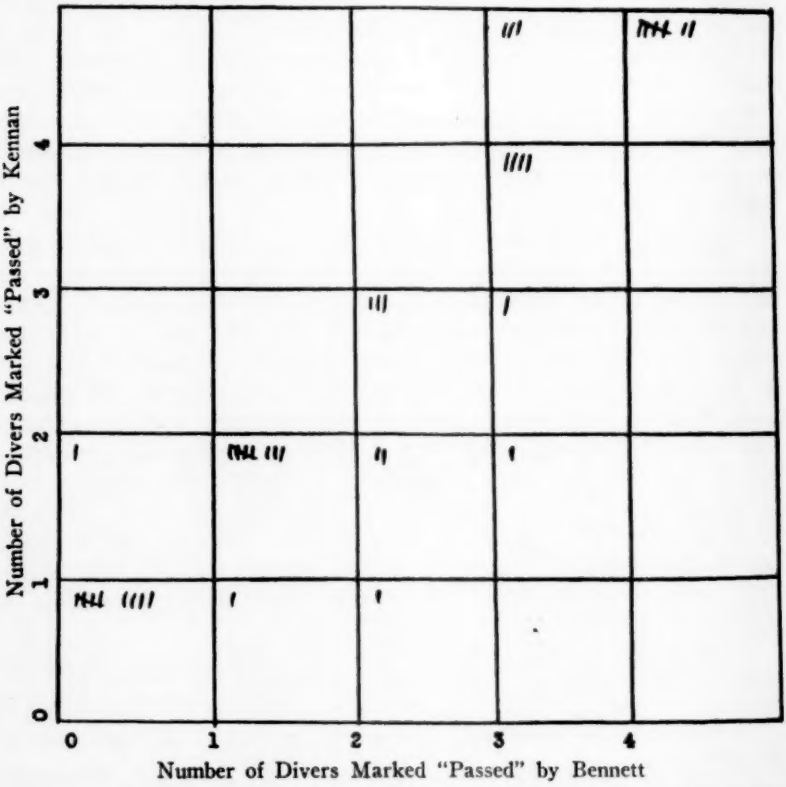

FIGURE I. Diagram showing the objectivity of all the test items of the objective test when judged by two experienced judges.

not have the problem of "weighting" dives according to difficulty. This paper proposes such a simplified test which includes items ranging from very simple stunts to difficult dives. The test has been found to be 92.9 per cent objective. The reliability (+.95) and validity (+.94) are both high enough to make the test of value for beginning classes.

An Annotated and Critical Bibliography of Books on Fencing

Prepared by STELLA FOX
Tutor, Hunter College
Department of Physical Education

1. Amateur Fencers League of America, *Members, Constitution* (1906) pp. 45.

This booklet is valuable only as a listing of the winners of championship medal contests from 1892-1904.

2. Amateur Fencers League of America, *Fencing Rules* (privately printed, New York, 1940) pp. 121.

The Rules Committee of the Amateur Fencers League of America has edited an excellent and most complete book on fencing rules. Included are the following: constitution and by-laws of the League; organization and discipline; and rules for the foil, sabre, and epee.

3. Angelo, Dominico, *The School of Fencing* (S. Hopper, London, 1765) pp. 63.

The book is one to delight a collector of fine fencing manuscripts. It is nicely written in old English script in both English and French. The passages dealing with the use of the rapier, dagger, cloak, and lantern are particularly interesting. The illustrations are excellent.

4. Barbasetti, Luigi, *The Art of the Foil* (E. P. Dutton & Co., New York, 1932) pp. 275.

Barbasetti's book is more for the teacher of the Italian style of fencing than for the student. A minute, detailed description of the Italian foil is given and the positions and movements of fencing are thoroughly explained. A history of fencing is well traced with excellent illustrations and many references to literature. Good teaching suggestions are interspersed throughout.

5. Barbasetti, Luigi, *The Art of the Sabre and the Epee* (E. P. Dutton & Co., New York, 1936) pp. 170.

Like his *Art of the Foil,* this book is better for the teacher than the student. A good series of exercises, graduating from simple positions to complex attacks, is given as a basis of lessons for a student.

6. Bennetton, Norman, A., *Social Significance of the Duel in Seventeenth Century French Drama* (Johns Hopkins Press, Baltimore, 1938) pp. 153.

In a well organized and thorough study of the seventeenth century French Drama, Bennetton traces the relationship of the duel in drama and its significance in society.

7. Bertrand, Leon, *Cut and Thrust* (Athletic Publications, Ltd., London, 1927) pp. 220.

Bertrand's book is to be recommended, especially to the sabre man. He writes smoothly and interestingly, with a good deal of attention to human personalities in fencing. In fact a good part of the book is spent in relating anecdotes about duellists and stage bouts. The explanation of sabre terms and techniques is clear and well written.

8. Betts, J., *The Sword and How to Use It* (Gale and Polden, Ltd., London, 1908) pp. 73.

Bett's explanation of sabre terms is good and his units of instruction for

the teacher are useful. The rules of judging included in this manual-form book are too old to be of value today.

9. Blakeslee, F. G., *Library of Fred Gilbert Blakeslee* (1926) pp. 6.

Blakeslee has just listed, according to date of publication, all books, pamphlets, manuscripts, and pictures relating to the sword, fencing, arms and armor, costumes, uniforms, and the theatre. He covers the period of 1787-1894.

10. Boston Fencing Club, *Constitution and By-Laws* (Boston, 1858) pp. 15.

A listing of officers and a presentation of the constitution and by-laws of the Boston Fencing Club are made. Particularly amusing are the rules forbidding admittance to all dogs and females.

11. Breck, Edward, *Fencing* (Spalding Collection, American Sports Publishing Co., 1894) pp. 50.

Breck's book, intended for the student, is of little use today. Fencing instructions are brief and, in places, antiquated. The historical sketch is inadequate. The illustrations, however, are simple and good.

12. Breckinridge, Scott, D., and Breckinridge, Scott, D. Jr., *Sword Play* (A. S. Barnes, New York, 1941) pp. 88.

The Breckinridges have presented an up-to-date discussion on the French school of fencing. The convention of "Right of Way" is very well explained under "Defense and Attacks," and good psychological pointers are given in "The Bout." Illustrations are unfortunately limited, but otherwise the book makes for good reference material.

13. Bryson, Frederick, *The Sixteenth Century Italian Duel* (University of Chicago Press, 1938) pp. 248.

Bryson presents a noteworthy detailed study of the sixteenth century Italian Duel. A thorough and technical discussion is given on the various phases of duelling, such as: challenging; necessary preparations; choice of arms; the actual combat; superstitions; and legal status. Interesting case histories of duels are included in the appendix.

14. Cass, Eleanor, *The Book of Fencing* (Lothrop, Lee, and Shepard Co., Boston, 1930) pp. 245.

Eleanor Cass' book is poor as a means of fencing instruction. She is concerned more with stage plays and fencing exhibitions than with actual good theory. A listing of fencing champions from 1892 on is included.

15. Castello, J. M., *Theory and Practice of Fencing* (Charles Scribners Sons, New York, 1933) pp. 269.

Castello gives an excellent exposition of modern fencing to be read by student and teacher. His history of fencing is very brief and inadequate, yet it is of value for its discussion of fencing in the U. S. The descriptions of positions and attacks are short and simple. A good series of exercises is presented for practice among all students. Emphasis is placed on correct, smooth execution of movement, rather than on touching.

16. Castle, Egerton, *Schools and Masters of Fence* (George Bell and Son, London, 1885) pp. 246.

With interesting excerpts from books written by or about famous fencing masters and schools, Castle has first shown the development of fencing from the Middle Ages through the eighteenth century. A discussion of fencing techniques is limited to a historical and developmental background. There is an excellently illustrated treatise on the development of the sword. The entire book is beautifully and copiously illustrated.

17. Chapman, George, *Foil Practice* (W. Clowes and Sons, London, 1861) pp. 50.

Chapman gives a rather lengthy explanation of fencing terms and movements. The book is out of date and of little value.

18. Corbesier, A. J., *Principles of Squad Instruction for the Broadsword* (J. B. Lippincott and Co., Philadelphia, 1872) pp. 47.

A brief sequence of instruction, for naval classes, in the use of the Broad sword, is presented in a concise and highly formalized style. The teacher of fencing might be interested in the suggested commands for mass instruction.

19. Dwight, Timothy, *A Sermon on Duelling* (Collins, Perkins and Co., 1805) pp. 38.

Dwight analyzes society's faulty reasons for duelling and condemns the practice as being, "foolish, irrational, and deserving only of contempt."

20. Elliot, W. J., *The Art of Attack and Defence* (Revised by W. Cooper, Dean and Son, London, 190?) pp. 20.

This book has little value today. It gives a very short description of fencing positions and movements in rather antiquated terminology.

21. Emerson, Edwin, *German Swordplay* (Graf and Breuninger, Philadelphia, 193?) pp. 65.

Emerson presents a very nicely written history of the development of German swordplay from the stone age on. The book is excellently illustrated and nicely anecdoted.

22. Fencers Club, *Officers, Members, etc.* (New York, 1908) pp. 25.

The book is of historic value only. It lists the officers, members, constitution, and rules of the club in 1908.

23. Griffiths, Thomas, *The Modern Fencer* (Frederick Warne and Co., London, 1868) pp. 91.

Griffiths has given short, simple explanations of fencing terms and positions for the beginner. With the exception of his twenty-four noteworthy "Observations on Fencing," the book is too outdated to be of use today.

24. Hershberger, H. R., *An Improved Sabre Exercise* (Henry Langley, New York, 1844) pp. 141.

The book is primarily concerned with the riding of a horse. Chapter Six presents a series of sabre exercises to be practised mounted or unmounted.

25. Hett, G. V., *Fencing* (Pitman Publishing Corp., New York, 1939) pp. 131.

Hett has written a very readable short guide for the "would-be" fencer. He excellently sums up the difference between the Italian and French schools of fencing. Practical suggestions are given regarding instruction, expenses, equipment, clothing, schools, etc. The book, though intended for the uninitiated, is worthy of perusal by the experienced fencer.

26. Hope, William, *A Vindication of the Art of Self-Defense* (W. Meadows, London, 1897) pp. 176.

The book is a precious antique to be treasured by collectors. It is a proposal made to the members of parliament for erecting a Court of Honor in Great Britain. Pointers on fencing are included.

27. Hutton, A., *Old Sword Play* (A. Gravel and Co., London, 1892) pp. 34.

Hutton discusses individually the different types of swords used throughout history. Concise directions for the use of each are given. The weapons included are the two-hand sword, the rapier and dagger, the broadsword and buckler, the rapier and cloak, and the dagger and cloak. The numerous plates make for excellent illustrative material.

28. Johnstone, John, *Fundamentals of Fencing* (Series of Lectures at the University of Michigan, Edwards Brothers Inc., 1932) pp. 114.

The theory of foil, sabre, and epee here presented, would be suitable for one already aware of fencing terms. The arrangement of lectures is rather confusing and consequently should be avoided by beginners.

29. L'Abbat, *The Art of Fencing* (James Hoey, Dublin, 1734) pp. 133.

L'Abbat's book would greatly please the collector of fencing manuscripts. Its value at present is that of a delightful antique study only.

30. Lidstone, Ronald, *The Art of Fencing* (H. Witherby, London, 1930) pp. 224.

The book is meant as a manual for beginners in the foil, sabre, and epee and its value is as such. Good preliminary hints are given to the novice, and actions are simply and clearly explained.

31. McArthur, John, *The Army and Navy Gentleman's Companion* (J. McMurray, London, 1784) pp. 162.

McArthur's book is another of those rare fencing manuscripts, worthy of a fencer's collection. The illustrations give a good idea of the costuming of the day.

32. Maclaren, Archibald, *A Military System of Gymnastic Exercises and a System of Fencing* (London, 1864) pp. 88.

A systematic presentation of positions, parries, and attacks is offered for the use of army instructors. The instructions are complicated and the arrangement of class lessons is of little value to the modern teacher.

33. Nobbs, Percey, *Fencing Tactics* (Philip Allan, London, 1936) pp. 250.

Throughout, Nobbs stresses the need for headwork rather than pure mechanical technique fully to enjoy and appreciate the art and spirit of fencing. The presentation of theory, in the use of the foil, sabre, and epee, is good but haphazard. I would not recommend the book for the beginner. An interesting discussion of the evolution and history of fencing, by Archibald Corble, should please all.

34. Olivier, J., *Fencing Familiarized* (John Bell, London, 1848) pp. 205.

As a source of instruction, Olivier's book has little value today, but as a part of a fencer's collection, it is a charming old-fashioned book as regards wording, printing, and illustrating.

35. Pollock, Grove, and others, *The Badmington Library of Sports and Pastimes* (Longman, Green and Co., London, 1889) pp. 110.

The brief introductory history of fencing by Grove is well written, interesting, and nicely anecdoted. Pollack gives a good discussion of the French system of fencing as based upon the famous Bertrand's methods. His definitions of terms and movements are easily understandable. The illustrations are good and the discussion on practical instruction is excellent for the teacher of fencing.

36. Roberts, L. E., *Military and Civilian Salutes* (pamphlet) pp. 7.

Roberts has drawn a good series of line figure diagrams, illustrating the preliminary exercises before an assault.

37. Roland, George, *A Treatise on the Theory and Practice of the Art of Fencing* (Archd. Constable and Co., Edinburgh 1823).

Roland's *Treatise,* in the form of questions and answers, though outmoded, is fuller and far better organized than his *Introductory Course of Fencing.* Interesting historical anecdotes are presented in the preface and the conclusion.

38. Roland, George, *An Introductory Course of Fencing* (Oliver and Boyd, Edinburgh, 1837) pp. 41.

This book has little significance today. Included are a brief historical background and a simple explanation of fencing fundamentals.

39. Roland, Joseph, *The Amateur of Fencing* (W. Wilson, London, 1809) pp. 228.

Roland's presentation is poor and extremely long-winded. The book is outmoded and completely lacking in illustrative material.

40. Senac, Louis and Regis, *The Art of Fencing* (American Sports Publishing Co., 1904) pp. 130.

Senac's book includes a good brief history of fencing; an entertaining passage on the "Rewards of Fencing," and a wordy but thorough study of the sport. Illustrations are plentiful.

41. Silver, George, Paradoxes of Defence, *Shakespeare Association Facsimiles No. 6.* (Oxford University Press, 1933) pp. 72.

Silver warns Englishmen against the teachings of Italian masters, and attempts to prove the advantages of the short sword over the long sword or rapier—a rare book which should delight the collector of fencing scripts.

42. Stonehenge and the Rev. J. G. Wood, *Spalding Collection, Fencing* (American Sports Publishing Co., 1863) pp. 44.

A brief and antiquated dissertation on the proper use of the rapier, is given in a manner and terminology of use only to the fencing historian.

43. Thimm, Carl A., *A Complete Bibliography of Fencing and Duelling* (Ballantyne Hanson and Co., London, 1896) pp. 538.

Thimm has provided a complete reference to every possible phase of fencing and duelling in all countries from the period of 1096 to 1896. Aside from the noteworthy thoroughness of the Bibliography and its Chronological Index, there are excellent and entertaining "Notes on Fencing and Duelling" in the form of interesting newspaper reviews, anecdotes, and articles.

44. Vince, Joseph, *Fundamentals of Foil Fencing* (Joseph Vince, Publisher, New York, 1937) pp. 53.

Fencing fundamentals are briefly defined and practise exercises are suggested for the beginner, for whom, however, a more thorough discussion is needed.

45. Waite, John, M., *Lessons in Sabre, Singlestick, Sabre and Bayonet, and Sword Feats* (Weldon and Co., London, 1880) pp. 150.

The greatest value of this book lies in its copious illustrations and entertaining articles on sword feats. Serious instructions are given for cutting through various articles, such as a sheep, a veil, an apple, etc., at one stroke of the sword.

46. Wayne, Henry, C., *The Sword Exercise, Arranged for Military Instruction* (Gideon and Co., Washington, 1850) pp. 43.

A somewhat outmoded setup is presented for the classroom teaching of the small sword, broad sword, sabre, cut and thrust, and stick as taught at the U. S. Military Academy in 1849. At present its main value lies in the "Precautions, General Observations, and Conclusion."

47. Young, William, *The Fencers Manual* (James Burrill, Chatham, 1840).

Young's book is simply a series of drills for practise in the use of the broadsword.

SUGGESTED READING LIST FOR THE STUDENT

1. Breckinridge, S. D., *Sword Play.*
2. Castello, J., *The Theory and Practice of Fencing.*
3. Castle, E., *Schools and Masters of Fence.*
4. Hett, G. V., *Fencing.*

SUGGESTED READING LIST FOR THE TEACHER

1. Barbasetti, B., *The Art of the Foil.*
2. Betts, J., *The Sword and How To Use It.*
3. Breckinridge, S. D., *Sword Play.*
4. Bryson, R., *The Sixteenth Century Italian Duel.*
5. Castello, J., *The Theory and Practice of Fencing.*
6. Castle, E., *Schools and Masters of Fence.*
7. Hutton, A., *Old Sword Play.*

8. Pollock, W., *Fencing.*
9. Thimm, C. A., *A Complete Bibliography of Fencing and Duelling* (pp. 439-534).

FOR THE COLLECTOR OF RARE MANUSCRIPTS

1. Angelo, D., *The School of Fencing.*
2. Castle, E., *Schools and Masters of Fence.*
3. Hope, W., *A Vindication of the Art of Self-Defense.*
4. L'Abbat, *The Art of Fencing.*
5. McArthur, J., *The Army and Navy Gentleman's Companion.*
6. Olivier, J., *Fencing Familiarized, or a New Treatise on the Art of the Small Sword.*

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2. Breck, E., *Fencing* (p. 4).
3. Cass, E., *The Book of Fencing* (pp. 13-20, 27-40, 51-58).
4. Castello, J., *The Theory and Practice of Fencing* (pp. 3-11).
5. Castle, E., *Schools and Masters of Fence.*
6. Emerson, E., *German Sword Play.*
7. *Fencer's Club Pamphlet* (1803).
8. Hutton, *Old Sword Play* (pp. 1-2).
9. Johnstone, J., *Fencing* (pp. 1-3).
10. Nobbs, P., *Fencing Tactics* (pp. 178-209).
11. Pollock, W., *Fencing* (pp. 1-3).
12. Senac, R. and L., *The Art of Fencing* (pp. 7-89).

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1. Angelo, D., *The School of Fencing.*
2. Barbasetti, L., *The Art of the Foil* (pp. 1-174).
3. Breck, E., *Fencing* (pp. 6-44).
4. Breckinridge, Scott D. Sr. & Jr., *Sword Play.*
5. Cass, E., *The Book of Fencing* (pp. 89-218).
6. Castello, J., *The Theory and Practice of Fencing* (pp. 12-146).
7. Castle, E., *Schools and Masters of Fence.*
8. Chapman, G., *Foil Practice.*
9. Elliot, W., *The Art of Attack and Defence.*
10. Griffiths, T., *The Modern Fencer.*
11. Hope, W., *A Vindication of the Art of Self-Defense.*
12. Johnstone, J., *Fencing.*
13. L'Abbat, *The Art of Fencing.*
14. Lidstone, R., *The Art of Fencing* (pp. 21-101).
15. McArthur, J., *The Army and Navy Gentleman's Companion.*
16. McClaren, A., *A Military System of Gymnastics, Exercises, and a System of Fencing.*
17. Nobbs, P., *Fencing Tactics* (pp. 57-116).
18. Olivier, *Fencing Familiarized.*
19. Pollock, W., *Fencing* (pp. 33-109).
20. Roberts, *Military and Civilian Salutes.*
21. Roland, G., *An Introductory Course of Fencing.*
22. Roland, *A Treatise of the Theory and Practice of the Art of Fencing.*
23. Senac, R., *The Art of Fencing* (pp. 29-98).
24. Stonehenge and Wood, *Archery, Fencing, and Broadsword.*

25. Vince, J., *Fundamentals of Foil Fencing.*
26. Wayne, H., *The Sword Exercise Arranged for Military Instructors.*
27. Young, W., *The Fencer's Manual.*

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1. Angelo, D., *The School of Fencing.*
2. Hutton, *Old Sword Play.*

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1. Kyrle, Bellew, "Stage Fencing and Fencers," *Outing* (April 1903), pp. 53-60.

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2. Cass, E., *The Book of Fencing* (pp. 307-328; 329-330 [Olympic])
3. Emerson, E., *German Sword Play* (p. 75).
4. *Riposte,* a magazine—all issues.

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1. Amateur Fencers' League—Publication of Rules.
2. Betts, *The Sword and How to Use It* (pp. 62-73).
3. Cass, E., *The Book of Fencing* (pp. 330-368).
4. Castello, J., *The Theory and Practice of Fencing* (pp. 247-269).
5. Johnstone, J., *Fencing* (pp. 83-114).
6. Lidstone, R., *The Art of Fencing* (pp. 202-226.
7. Nobbs, P., *Fencing Tactics* (pp. 233-250).
8. *Riposte,* a magazine—all issues.
9. Senac, R., *The Art of Fencing* (pp. 111-117).
10. Waite, J., *Lessons in Sabre, Singlestick, etc.* (pp. 91, 145-151).

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1. Emerson, E., *German Sword Play* (German-English—pp. 66-75).
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Signs of Health and Health Habits among College Freshmen

By M. V. Marshall and B. J. Allison
Franklin and Marshall College

IN 1917 a comprehensive survey of the health of America's young men was made by the army medical officers. A similar survey is now beginning again. In the meantime it is important for schools, parents, and health experts to be as well informed as possible of the physical condition and healthfulness of habits among the youth who, the finished product of homes and schools, are just entering manhood.

This study is of this nature. Although limited in scope, in the number of young adults included, and in its methods, it furnishes some facts about the effectiveness of the physical culture program through which one generation of young men has come.

The following questionnaire was given to 218 college freshmen—all men—of average age eighteen in October, 1939. All the sources of error and unreliability inherent in the questionnaire technique occur here, although precautions were taken to make the results as reliable as possible. The compiled results are given as percentages of the total of 218.

HEALTH SCORE CARD

Directions: Place an X in the column of the five at the right that is best suited to your answer to the question on the left.

	Always or Completely	Most of the Time	50 - 50	Very Little or Seldom	Never or None
Part I. Signs of Health.					
1. Can you work and play without being more than naturally tired mentally or physically at bed-time?	26.6	51.4	13.8	5.9	2.3
2. Are you rested when you get up in the morning?	21.1	55.1	16.5	6.8	0.5
3. Is your appetite good for wholesome food?	76.1	22.4	0.5	0.5	0.5
4. Are you free from persistent trivial worry?	25.2	22.5	43.1	7.8	1.4
5. Do you enjoy mingling with other people?	64.2	29.4	5.9	0.0	0.5
6. Does your posture indicate health and efficiency?	43.1	39.2	14.8	1.8	0.9
7. Are your arches normal and are you free from pain in your feet and legs?	79.3	14.7	1.4	3.2	1.4
8. Is your vision either normal or corrected by glasses?	86.2	5.5	6.0	0.9	1.4
9. Can you hear ordinary conversation at 16 feet?	85.7	12.4	0.9	0.5	0.5
10. Is your skin clear, color good?	50.5	34.4	12.8	1.9	0.5
11. Are your teeth either sound or filled?	79.7	12.2	6.8	1.3	0.0

12. Are you free from constantly recurring infections including colds?	43.1	40.8	8.7	4.6	2.8
Part II. Health Habits.					
1. Are you eating some dark bread daily?	29.2	16.3	14.2	22.9	17.4
2. Do you drink six glasses of water every day?	44.5	26.1	20.2	5.1	4.1
3. Do you average at least 8 hours sleep every night?	29.3	40.0	21.1	7.8	1.8
4. Do you eat sweets in moderation?	32.6	32.1	25.2	8.7	1.4
5. Do you eat only at mealtime? (Fruits may be excepted)	22.0	42.1	21.1	7.4	7.4
6. Do you eat two vegetables, exclusive of potato, every day?	52.3	34.0	10.1	2.7	0.9
7. Is one of these an uncooked vegetable?	25.7	30.8	27.5	12.8	3.2
8. Do you eat fruit at least once a day?	55.1	28.4	10.1	4.6	1.8
9. Do you eat one of the following every day? (meat, milk, cheese, nuts, fish, egg)	86.7	10.5	1.8	0.9	0.0
10. Do you take your meals regularly?	62.8	31.2	4.1	1.4	0.5
11. Do you eat slowly?	21.1	36.3	29.8	8.7	4.1
12. Do you take a full bath at least twice a week?	84.4	12.0	2.7	0.9	0.0
13. Do you clean your teeth at least twice a day?	54.0	25.0	14.5	4.3	2.3
14. Do you have a bowel movement every day without a cathartic?	72.0	24.8	1.4	1.8	0.0
15. Do you exercise vigorously at least half an hour every day (either outdoors or in)?	36.3	35.8	17.4	8.7	1.8
16. Do you average at least an hour outdoors every day?	71.6	19.2	7.8	1.4	0.0
17. Do you take at least ten hours every week for recreation, social activity, reading, etc. (in addition to daily exercise)?	52.7	31.7	6.0	7.3	2.3
18. Have you a vital and satisfying interest outside of your work?	71.6	17.9	9.6	0.9	0.0
19. Do you have your bedroom window open at night?	85.7	10.1	1.4	2.3	0.5
20. Do you endeavor to maintain your best standing and sitting posture?	35.8	45.0	11.9	6.4	0.9
21. Do you have a thorough physical examination once a year?	58.3	22.0	8.7	6.4	4.6
22. Does your dentist examine your teeth twice a year?	70.4	13.7	7.8	5.9	2.2
23. If you have physical limitations, do you know them and live within them?	54.0	27.2	10.8	4.8	1.8

CONCLUSIONS AND COMMENTS

1. The general conclusion is not unfavorable. There are 35 questions about common signs of health and health habits. In the case of 27 of the questions, the majority of the freshmen put their responses in the "Always" column, for 7 questions the majority responded in the "Nearly Always" column, and for only one question was the response of the majority of freshmen in the 50-50 column. In no case did the majority respond below the "50-50" column; in fact, the percentage who responded below the "50-50" column was very small, less than 15, except for three of the questions. And, again, the percentage of students who responded in the "50-50" column was usually small; in only 7 out of the 35 questions was it higher than 20 per cent.

So it seems justifiable to conclude that college freshmen, as repre-

sented by this group, rank high in their possession of certain common signs of health and health habits.

2. The exceptional cases may be indicative of important health weaknesses that should receive attention.

a) The only question to which the majority of freshmen responded in the "50-50" column was, "Are you free from persistent trivial worry?" This represents the lowest state of good health that the questionnaire showed up. It may be that the highly subjective nature of the question accounted for the low response. Or, it may be that this does actually represent an area where our young men are defective, and, inferentially, a point where our health program is weak.

b) There are six questions on the second part of the questionnaire to which more than 10 per cent of the freshmen responded in the "Very Little" and "Never" columns combined.

	Low Response
Are you eating some dark bread daily?	40.3
Do you eat only at mealtime?	14.8
Do you eat an uncooked vegetable daily?	16.0
Do you eat slowly?	12.8
Do you exercise vigorously at least half an hour each day?	10.5
Do you have a thorough physical examination every year?	11.0

These can be explained as due to various reasons: dark bread and uncooked vegetables are not always available at eating establishments; the impulses of youth to hurry and to surrender to appetite regardless of the clock; the cost of doctors' fees for medical examinations; and the pressure of time under certain work or study schedules. In some cases the value of the health habit is not accepted as highly important universally.

The significance given to the facts will depend upon the weight which is given to the habits. The greatest tendency to "view with alarm" will, however, be mitigated by the small percentage of offenders.

3. Finally, one could wish that both columns to the right were completely blank—that there were no young men whose responses to these health questions were "Very Little" or "Never." We should like to see all our youth completely fit. The presence of the marginally healthy is to be deplored and is an incentive to strengthen our public and private health efforts. However, some of the individuals whose responses were in the low columns have been the victims of congenital defects, of accidents, and of unfortunate circumstances. A few of them will be present, under the best of conditions, to respond to such questions in the "Very Little" or "Never" columns.

BOOK REVIEWS

ORIENTATION IN SCHOOL HEALTH. Clair V. Langton. (New York: Harper and Bros., 1941) 680 pages, $3.00.

Dr. Langton discusses in considerable detail many hitherto neglected phases of the school health program in his new book, *Orientation in School Health*. The volume provides an excellent and well-rounded discussion of the organization and administration of the school health program as a whole, but concentrates on aspects of the subject that are less understood. Material presented herein is the result of a careful selection and painstaking study, over a period of twenty years, of data offered through courses and lectures to students of education, physical education, and public health in institutions of higher education. It is the purpose of this book to orient public school personnel in the organization and administration of the school health program.

Hygiene instruction, physical education, and mental hygiene are not developed in this particular volume because they are recognized and accepted by the school administrators. Teacher-training programs have made a definite attempt to provide education in these fields. Voluminous material is available on these three topics.

There are, however, certain phases of the program which the educational administrator has understood less clearly and in which his background is much more meager. This book brings together the essential facts, analyzing technical material in simple yet accurate terms and applying it to practical use in the school as far as possible in three particular areas: (1) the prevention and control of communicable disease; (2) healthful school living, or the sanitation of the school; and (3) hygiene of the school child.

Basic fundamental principles and good practice are emphasized, but no attempt has been made to treat the material exhaustively. For anyone who wishes to investigate any topic further, excellent bibliographies are provided throughout the book.

The introduction contains interesting discussions of the history of the school health program; agencies interested in the health of the school child; the need for unified organization; trained personnel necessary for an effective program; the effect of school size upon program; a suggested organization of the program; the philosophy of social services in school; and a declaration of policy.

It is obvious that the author's training and background in public health have influenced the emphasis on certain types of content in the school health program. Material presented reflects the best practices in public health, and, in many cases, presents the results of very significant studies that have been made.

Of particular interest to the teacher are the chapters on Growth and Development, and Nutrition and Malnutrition. Instructors will find the chapters on Safety Education and on Teacher Health of special importance.

Parts I and II will be of primary consideration for school administrators, although chapters on General Factors in Disease Prevention and the section dealing with the dissemination of disease and immunity and resistance to disease illustrates the author's thorough knowledge of these particular areas.

An excellent section on the hygiene of instruction should be read by all superintendents and principals. This area in the past has been neglected badly. If health education in the

school is to be a functional and effective program, it is essential that the school program be arranged in a healthful manner for both teacher and students.

The book is unusually well illustrated with very excellent charts and diagrams.

While *Orientation in School Health* is ideal for textbook use in teacher-training programs, its general use by school personnel in service is strongly recommended.

Ross L. Allen
University of Michigan

Career Coach. Earl Schenck Miers. (Philadelphia: The Westminster Press, 1941) 258 pages, $1.50.

It is not often that a professional publication such as the *Quarterly* carries reviews of books of fiction, yet here, in *Career Coach*, we have a title that we feel deserves mention in these pages.

Career Coach, briefly, is the story of an All-American football player turned coach and of the troubles and tribulations he has in his first year. The conflict between the all-consuming urge to win at all cost as typified by some of the hardened alumni and a part of the athletic board on the one hand, and Craig Bannister's high ideals is well portrayed. Bannister's desire to win and become a successful coach at first caused him to weaken, but in the end his ideals win out. The sister of the freshman football star supplies the love interest, an interest well-tempered for readers of all ages.

The value of *Career Coach* to the physical education field is that it supplies us with a book that presents in a very readable form the problems that confront the young coach in big time athletics. It is a book that the physical educator or coach can well recommend to the young high school athlete who contemplates coaching as a career. While some of the scenes are rather forced and the author has, we feel, gone to some pains to make the conflict between good and bad in athletics very sharp, the book has, nevertheless, the essential elements of interest.

This book is one of the first of a new series of books by the Westminster Press that are planned particularly for American youth.

Wilson M. Ranck
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Hackley Public Library
Muskegon, Michigan

Attention! To Your Health. Ernest I. Stewart, Jr. (New York: Bureau of Publications, Teachers College, Columbia University, 1942) 82 pages, $0.35.

In 1940 the National Education Association and the American Council on Education created the National Committee on Education and Defense. This national committee, in cooperation with the Pre-Induction Education Committee of Teachers College, Columbia University, subsequently sponsored the preparation of three handbooks to assist young men eligible for enlistment or induction into the armed forces of the nation.

Attention! To Your Health is one of these handbooks. It deals with the personal hygiene of the soldier: problems of personal health that young men encounter both while they are in Army camps and while on leave in the areas surrounding Army cantonments. Topics range from those of dental and mental hygiene to problems concerning the use of alcohol, and the choice of suitable eating places while off duty and "in town." Consideration is given to veneral disease and prostitution in the areas around army camps.

This publication couches the latest available health facts in nontechnical language and applies them directly to specific Army situations. All materials are presented in a number of short, concise chapters with headings that have a special appeal to young men. For example, the chapter on clothing is entitled, "Khaki Clad"; mental hygiene has the caption, "Getting Along"; and the control of communicable diseases is called, "Fifth

Columnists within the Ranks." The book is well written, and fully illustrated with Army cartoons. It is intended that the book shall serve as a valuable guide to men already in camps as well as to those about to enter military service.

Attention! To Your Health may be distributed individually to the men, or used in connection with college, high school, or adult education classes.

Teachers College,
C. L. BROWNELL
Columbia University

ERRATUM

The following correction should be inserted on page 652 of the SUPPLEMENT TO THE RESEARCH QUARTERLY for October, 1941—the volume on "Pioneer Women in Physical Education": "Material giving life and work of Dr. Delphine Hanna was compiled from 'An Historical Analysis of the Professional Career of Delphine Hanna,' a thesis by Minnie L. Lynn, M.S., The Pennsylvania State College, 1937; A.B., Oberlin College, 1928."